PROJECT DEMONSTRATING EXCELLENCE

Neural Correlates of Nondual Awareness

by

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Abstract:

This dissertation presents and explores, through theoretical analysis, a new hypothesis that the neural correlates of space in the posterior parietal cortex mediate nondual awareness, in conjunction with the areas in prefrontal cortex. It examines nondual awareness, pure consciousness occurring with experience, through the study of the Tibetan Buddhist traditions of Dzogchen and Mahamudra and the Hindu tradition of Advaita Vedanta, and explores the neural correlates of nondual awareness through the study of contemporary scientific meditation research. Functional Magnetic Resonance Imaging (fMRI) data from a single case study are presented in support of the argument. The conclusion from this study is that the neural correlates of space in the posterior parietal cortex mediate nondual awareness in synchrony with the medial and dorso-lateral areas of the pre-frontal cortex. This large-scale synchrony provides a context for the nondual unfolding of perceptual, affective and cognitive processes without fragmenting the field of experience into subject and object. The sameness of internal and external space that characterizes nondual awareness is reflected in the simultaneous harmonious functioning of the ordinarily anti-correlated intrinsic and extrinsic neural networks. It is suggested that this larger integrated network may be the long-sought neural correlate of the unified consciousness. This study points to the need for future research into the functioning of the pre-frontal, parietal and occipital areas in nondual awareness, through meditation studies using neuro-imaging techniques such as fMRI.

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CHAPTER ONE: INTRODUCTION

Topic of research

Through theoretical analysis, this dissertation explores a new hypothesis that the neural correlates of space in the posterior parietal cortex mediate nondual awareness, in conjunction with the medial and dorso-lateral areas of the pre-frontal cortex. It examines what nondual awareness is, through a study of the Tibetan Buddhist traditions of Dzogchen and Mahamudra and the Hindu tradition of Advaita Vedanta, and explores the neural correlates of nondual awareness through a study of contemporary research in Cognitive Neuroscience. It offers a theoretical synthesis which points to the possibility that the sameness of internal and external space that characterizes nondual awareness is reflected in the simultaneous harmonious functioning of the ordinarily anti-correlated extrinsic and intrinsic neural networks, and that this larger network may be the long-sought neural correlate of the unified nature of consciousness.

In order to answer the research question: " Do the neural correlates of space in the posterior parietal cortex mediate nondual awareness, in conjunction with the medial and dorso-lateral areas of the pre-frontal cortex?" the literature is reviewed in light of the current findings and limitations of research on the neuroscience of nondual awareness. In addition, functional Magnetic Resonance Imaging data from a single subject are presented in support of the hypothesis. This data is a part of a larger study of the neural correlates of nondual awareness

presently conducted by this researcher at the Mental Imagery and Human-Computer Interaction laboratory at Rutgers University, Newark, NJ.

Using the method of the theoretical analysis, this dissertation will show that nondual awareness is pure consciousness occurring with experience, and that the neural correlates of space in the posterior parietal cortex mediate nondual awareness in synchrony with the medial and dorso-lateral areas of the prefrontal cortex. This large-scale synchrony provides a context for the nondual unfolding of perceptual, affective and cognitive processes without fragmenting the field of experience into subject and object. Furthermore, the sameness of internal and external space that characterizes nondual awareness is reflected in the simultaneous harmonious functioning of the ordinarily anti-correlated intrinsic and extrinsic neural networks.

As defined in the above-mentioned Asian contemplative traditions, nondual awareness denotes open-ended space-like cognizance which, as a context, can encompass all experiences. It is a self-knowing, luminous consciousness that can be described as inseparable being-awareness-bliss. When stabilized through the practice of meditation, nondual awareness can accommodate all states and functions of consciousness. Within its context, the essential qualities of human being-ness (strength, love, compassion, joy, wisdom, etc.) unfold spontaneously.

Especially in Advaita Vedanta and Dzogchen, nondual awareness is distinguished from the states of consciousness (such as waking and dreaming) and

from the functions of consciousness (such as perception, memory, attention, and imagination). Thus, the meaning of the term "awareness" in Asian nondual philosophies is rather different from its meaning in contemporary Western philosophy and neuroscience. For example, in the Western sources awareness is alternatively defined as a consciousness modulated by the mind (Tart, 1972), as a self-representation based on memory (Lou, 2004), as a state where one has access to information (Chalmers, 1996) or as the access consciousness (Block, 2005). But these characteristics do not apply to nondual awareness as understood in the Asian nondual philosophies.

As described later in more detail, nondual awareness is defined in this dissertation as pure consciousness operating with experience. The various Sanskrit and Tibetan terms for this level of consciousness (Atman, Atma-jnana, Prajanana, rig-pa, ye-she, she-rab, etc.) have been translated as *nondual awareness*, rather than as already available terms such as Self, Self-knowledge, timeless awareness, pristine awareness, and pure presence—because the term *nondual awareness* best captures the fundamental property of this level of consciousness: It experiences everything non-dually, without fragmenting the field of experience into subject and object.

Significance of the Present Research: Problem Statement

A major issue in meditation research today is the paucity of recent studies, and in particular, the need for meditation studies that have been rigorously designed. For example, at the time of this writing, there are only two meditation

studies published in 2005, while in 2004 there were only a few more. In addition, a review of the issues in scientific research of spirituality and meditation by a major researcher in this field (Newberg, 2005) lists only six studies of meditation that have made use of the modern brain scanning techniques, such as fMRI or SPECT. This problem is especially pronounced in respect to the research of nondual awareness and pure consciousness. There are no published neuroimaging studies of nondual awareness, pure consciousness occurring with experience, at the time of this writing, and only one EEG study (Travis, Tecce, Arenander et al., 2002). There are several scientific studies of pure consciousness alone, that is, pure consciousness without experience, by Arenander and Travis at the Maharishi University of Management (Arenander, 1996; Travis, 1994; 2001, 2003; Travis & Pearson, 2000) and the two by D'Aquili and Newberg at University of Pennsylvania (Newberg et al. 2001; Newberg & Iversen, 2003). Given the importance of nondual awareness to the overall research of consciousness, this lack is significant. The present study is an attempt toward rectifying this problem.

The meditation research reviewed here is a thorough description of what has been done so far, at the time of this writing. However, in light of the ongoing refinements of scanning techniques and data analysis software, it is likely that many of the findings presented here will soon be outdated. In addition, fMRI research of meditation is very much an emerging field, and the current surge in interest is sure to result in many new and exciting findings. Furthermore, meditation research presents unique challenges, as it requires a multi-disciplinary approach that combines the Asian nondual philosophies, which developed the

understanding and the techniques for accessing nondual awareness, with the scientific experimentation found in Cognitive Neuroscience, and the precise first person reporting found in Clinical Psychology and in Phenomenology (Varela & Shear, 2002).

The nature of the neural correlates of consciousness (NCC), or what in the brain correlates to our experience of being conscious, is one of the great, unsolved mysteries of science, likely to be the central focus of scientific research in the twenty first century (Metzinger, 2002). The search for the NCC is one of the most broad scientific pursuits today, bringing together a number of different fields, such as philosophy, psychology, neuroscience, computational modeling, cybernetics, and even quantum physics. However, as several writers point out (Chalmers, 2000; Searle, 2002), research into the nature of consciousness is hampered by the difficulty of defining what exactly consciousness is. The knowledge obtained in the nondual contemplative traditions of India and Tibet about non-conceptual and non-ordinary states of consciousness provides present-day scientific research with important clues and signposts related to the nature of consciousness (Davidson, 2004c). For example, the Dzogchen and Mahamudra traditions of Tibetan Buddhism and the Advaita Vedanta tradition of Hinduism make a clear distinction between the <u>nature</u> of consciousness (pure consciousness), and its various <u>modalities</u> such as its states, functions and contents. This knowledge can contribute positively to the search for the neural correlate of consciousness (NCC). It implies that, in order to find the NCC, one must research the correlates of the fundamental <u>nature</u> of consciousness, not the

correlates of various states and functions of consciousness. Finding the neural correlates of nondual awareness (of pure consciousness functioning with experience) is then an important component in finding the neural correlate of consciousness.

Even among those researching meditation, there seems to be a lack of understanding of the difference between the nature and modalities of consciousness. For example, both Lazar et al. (2000) and Lou et al. (1999) have researched meditations involving the activity of the conceptual mind. Thus, they found correlates of the functions of consciousness and not of consciousness itself.

Furthermore, different researchers in the field of neuroscience are interested in different dimensions of human experience. For example, Davidson and his team at the University of Wisconsin have been focused on the effects of meditation on emotions. Newberg (2000) discusses an idea of the Absolute Unitary Being, but does not differentiate it from nondual awareness. Travis, on the other hand, has primarily researched pure consciousness that occurs in states of deep absorption when most waking and dreaming experiences are temporarily suspended. However, as the Dzogchen tradition eloquently demonstrates, it is not necessary to approach pure consciousness in this way—because as nondual awareness it is always present as the space-like context of all experiences, regardless of what one is experiencing.

While the Tibetan Buddhist traditions of Dzogchen and Mahamudra and the Hindu tradition of Advaita Vedanta can offer significant contributions to the overall search for the nature of consciousness, there are contradictions in their

descriptions of the nature of nondual awareness, and these have served as the focal point of centuries-old debates. Empirical evidence from cognitive neuroscience research that examines nondual awareness in relation to human neurophysiology can, in turn, contribute toward resolving some of these longstanding arguments.

Present research on the neural correlates of nondual awareness contributes to finding the neural correlate of consciousness by re-focusing attention on the presence of consciousness itself as the context, or the foundation of all experiences and cognitive processes. This, in turn, could advance the possibility of researching whether a continuum of consciousness can exist even in the absence of the physical body. In addition, one of the chief features of nondual awareness in daily life is the experience of relaxed spaciousness, of comfort and ease with oneself, and of harmony with one's environment. As such, furthering the understanding of nondual awareness as an aid to realizing such awareness can help remedy the existential discontent that plagues humanity.

Definition of the Fields

In the present study, the field of Asian philosophy is limited to the following Indo-Tibetan traditions: Advaita Vedanta of Hinduism, and Dzogchen and Mahamudra of Tibetan Buddhism.

Advaita (Sansk. nondual) Vedanta is a branch of Vedanta based on three root texts—the Upanishads, Brahma Sutra and Bhagavad Gita. Vedanta, in many ways, forms the core of Hinduism (Klostermaier, 1994). It has evolved into three

distinct philosophical orientations: Advaita (nondualist), Visishtadvaita (qualified monist) and Dvaita (dualist). The primary concerns of Advaita Vedanta are the ultimate nature of self-identity and the ontological status of Being. The nondual Advaita philosophy of Vedanta is the essence of the earliest Upanishads, the Brihadaranyaka and Chandogya (c. 1500-800 B.C.E.), which were later extrapolated to form the Mandukya Upanishad (c. 350 B.C.E.). According to its followers, the Brahma Sutras, composed sometime in the fifth century B.C.E., present the earliest record of systematized arguments in support of the views of Advaita Vedanta and against those of other philosophies current at the time in India (Vireshvarananda, 1993). However, Advaita Vedanta as a philosophical system was fully explicated only much later by Gaudapada (c. 550-650 C.E.) and Shankara (788-820 C.E.). Later commentators, representing different interpretations of Vedanta—most notably Ramanuja (1017-1137 C.E.), the founder of Visishta-advaita or the qualified monism school, and Madhava (1238-1317 C.E.), the founder of the dualistic school of Vedanta—offered different interpretations of the verses of the Brahma Sutra, challenging the nondualist viewpoint (Hamilton, 2001). Today, the followers of Advaita Vedanta regard their philosophy as the only true expression of the original insight of the ancient Hindu sages (Radhakrishnan, 1995).

The Tibetan Buddhist traditions of Dzogchen and Mahamudra belong to the two different streams of Indian Tantric Buddhism that were transmitted to Tibet at different times. The first transmission, occurring in the eighth and ninth centuries C.E., forms the so called "old school" of Tibetan Buddhism found in the

Nyingma sect and includes Dzogchen teachings which are characterized by their direct introduction to nondual awareness. The second transmission, occurring in the eleventh century and later, forms the "new schools" of Tibetan Buddhism found in the Kagyu, Gelug and Sakya sects, the central teachings of which are the Mahamudra and the six yogas of Naropa. The approach employed in the six yogas of Naropa is to first isolate pure consciousness, and then re-integrating it with all experiences as nondual awareness (Dalai Lama, 1980).

Cognitive neuroscience is a relatively new field that emerged as a crossbreed of neuroscience and cognitive psychology (Cabeza & Kingston, 2001). The designation "cognitive" in this context means that the scientific experiments are observations of human subjects with the aim of understanding higher mental functions.

Limitations

In addition to the limitations of the fields as defined above, the other major limitation that applies to the focus of this dissertation is the relative lack of recent scientific studies of meditation.

Delimitations

The data sample, while used only to illustrate certain points in the methodology and discussion sections, contains several de-limitations: 1. Only experienced mediators were considered as subjects as it was expected that they would be able to meditate inside a noisy scanner and that their scans would show clearly distinguishable patterns of activations; 2. Only one subject was selected as an example due to the time constraints; 3. Within-subject design was used, where

the subject served as his own control; 4. The block design compared nondual awareness to rest, and to counting (adding simple numbers), raising the issues of the function of the brain at rest, and of the lack of functional segregation in the parietal cortex, which are discussed in the 'Analysis' and 'Discussion' chapters, respectively.

While the nondual Asian philosophies examined offer an alternative to the problems of constructivism and functionalism found in Western philosophy and neuroscience, the present work does not concern itself with Western perspectives on these Asian traditions. (For such treatment, see Guenther, 1977, 1984.) Also, as mentioned at the beginning of this introduction, the present focus is on the phenomenological dimension of nondual awareness. The ontology, metaphysics and various theological implications of nondual awareness are not discussed, except briefly where necessary. In addition, this study does not concern itself with the ongoing debate between the perennialists and the constructivists regarding the existence of pure consciousness (For this, see Forman, 1989, 1998; Katz, 1978).

In the treatment of the Asian contemplative traditions, this research does not focus on such longstanding issues as the nature of self, the meaning of emptiness and causality, or on the issues of epistemology. Also, while the views on the nature of consciousness in these traditions are examined as they pertain to the topic of study, this dissertation is not focused on determining what is the nature of consciousness.

With respect to the field of cognitive neuroscience, not all meditation research is relevant to this dissertation. For example, a great number of meditation

studies, especially the early ones, focus solely on the physiological markers of meditation. Also, this dissertation does not include a meta-analysis of meditation research.

GLOSSARY

Abhidharma - (Sansk.) Compilation of early Buddhist philosophy and psychology; also known as 'Special Teachings', third part of the Buddhist canon Tripitaka.

Alaya-Vijnana -(Sansk.) 'Storehouse consciousness' Term coined by Vasubhandu to indicate the unconscious level of mind that stores memories.

Atman - (Sansk.) 'Self' with capital 'S'—a term originating in early Upanishads and denoting, in Nondual or Advaita Vedanta, the ultimate self-identity as pure consciousness (or as nondual awareness) transcending the body, energy, and mind; to be differentiated from 'self' with small 's' which stands for personality, and also from 'soul'.

Axon – Neuronal branch that transmits signal to another neuron.

Binding - Processes by which the brain puts together or binds the sensory information into a coherent experience .

Blocked design – In fMRI studies indicates separation of conditions into blocks.

Brahman - In Advaita Vedanta: the Absolute, pure consciousness pervading the Universe; or alternatively, the totality of existence which includes both the pure consciousness and the different dimensions of creation/experience.

Brodmann Areas (BA) – Mapping of the brain into cytoarchitectonic areas by Korbinian Brodmann.

Cluster-size tresholding – Adopting a number of voxels whose activation can be regarded as significant.

Dendrite – Neuronal branche that serves as receptor for other neuron's axons.

Dzogchen - Great Perfection or, Clear Light Great Perfection, a branch of Tibetan Buddhism emphasizing the realization of innate, non-conceptual awareness.

EPI – Echo-planar imaging; a techniques of fast acquisition of MR image through changing of the gradients.

fMRI - Functional Magnetic Resonance Imaging; a method of obtaining images using magnetic resonance that shows the functional activity of the brain over time.

Glial cells – Brain cells involved in supporting the metabolism of neurons.

Gunas - (Sansk.) Term used in Sankhya-Yoga philosophy denoting the three modes that qualify all phenomena: inertia, activity and balance; psychologically the term implies three states of mind: dullness, passion and purity.

Kaya - *(Sansk.)* lit. 'body'; Dimensions of Buddha-nature, or enlightenment. Three,four or five kayas are outlined depending on the tradition: *Dharmakaya* body of truth; *Sambhogakaya*—body of self-enjoyment; *Nirmanakaya*—body of emanation; *Svabhavikakaya*—body of all states; *Mahasukhakaya*—body of great pleasure

Madhyamaka - Buddhist philosophy founded by Nagarjuna (c. 2nd century C.E.) based on the negativistic logic: phenomena neither 'exist', nor 'not exist'; neither 'both exist and not exist'; nor 'neither exist nor not exist'. A logical analysis designed to relax conceptual grasping.

MRI - Magnetic Resonance Imaging—method of obtaining medical images using magnetic resonance.

Neuron – Brain cell whose function is the coding, storage and transmission of information.

Neural correlate – Distributed pattern of neuronal activity corresponding to experience.

Neural Representations – a.k.a. 'distributed representations' Encoding of information in neural networks, which when activated, enable access to this information.

Nondual Awareness - Pure consciousness functioning with experiences.

Nonduality - (Sansk. Advaita) 'not-two', oneness, an absence of fragmenting of the field of experience into self and other.

Pure Consciousness - The nature of consciousness, luminous cognizance devoid of content.

Qualia - Subjective experience of thoughts, feelings and perceptions.

Self-Knowing Awareness - (Tib. Rang-rig) Awareness recognizing its own nature.

Space of phenomena - (Sanks. Dharmadathu) Space that is the context of all experiencing, in which phenomena appear in their true dimension, just as they are.

Stereotaxic Space – Mapping system using 3-D coordinates.

Synchrony - Oscillating of large populations of neurons at same frequencies.

Tantra – Within Buddhism and Hinduism, a method of practice that includes the body and sexual energy.

Voxel – a three-dimensional segment of the brain used as the unit of volume.

Yogachara - Buddhist philosophy created by Vasubhandu and his older brother Asanga in response to Madhyamaka of Nagarjuna. It emphasizes structuring of the mind, and the reality of the enlightened nature.

CHAPTER TWO: REVIEW OF LITERATURE A—NEUROSCIENCE

The scientific research of meditation has existed now for well over half a century, with the field gaining significant new momentum recently, stimulated by the development of new technologies such as the fMRI, SPECT and MEG, and the advancements in data analyzing software. Renewed interest in this field has been stimulated by the inspiration of the XIV Dalai Lama, Tenzin Gyatso, through the Mind and Life Institute programs.

While the general overview of meditation research is outside the scope of this dissertation, (for an extensive treatment of this topic, see Andresen, 2000; Cahn & Polich, in press; Murphy & Donovan, 1999; and Shapiro & Walsh, 1984), four areas of research can be identified: physiological markers of meditation, the effects of meditation on emotions, the effects of meditation on cognitive functioning, and the nature of meditative consciousness itself.

As mentioned in the introduction, a major issue in meditation research today is the lack of recent studies, especially the lack of studies of the nature of consciousness. The vast majority of meditation studies have been concerned with the effects of meditation on health and on physiological markers. Most of these studies have been carried out by three groups of researchers: the transcendental meditation team that includes Fred Travis, Alaric Arenander, and David Orme-Johnsson at Maharishi University of Management; Herbert Benson's team researching the relaxation response at Harvard Medical School; and the

mindfulness-based stress-reduction program run by John Kabat-Zinn at the University of Massachusetts Medical School.

The most recent trend in meditation research has been toward exploring the neural correlates of meditation utilizing modern diagnostic techniques of fMRI, PET and SPECT (Newberg, 2005). These studies are, for the most part, reviewed later in this chapter, in the section on the nature of meditative consciousness.

The review below will first focus briefly on the most relevant studies in the three areas: physiological markers of meditation, the effects of meditation on emotions, and the effects of meditation on cognitive functioning. Then, the more recent meditation research on the nature of meditative consciousness will be examined in detail.

Physiological Markers of Meditation

Prior to any discussion of the effects of meditation, it is necessary to emphasize that meditation is not a uniform technique. There are numerous meditation techniques, and the task of accurately systematizing them is much needed in today's fields of Cognitive Neuroscience and meditation research. Meditation is also not a subset of some other technique, as some have suggested (Cahn & Polich, in press). Rather, meditation is the central means by which a practitioner re-connects with the ultimate meaning of reality. As such, it carries a significant subjective bias not easily controlled for in meditation studies.

Until recently, the studies of the physiological effects of meditation have primarily focused on its relaxation effects. The stimulating effects of certain meditation techniques have been explored to a much lesser degree. This has led to a misperception of meditation as primarily a relaxation technique.

Wallace, Benson and Wilson (1971) found that the transcendental meditation or TM technique produces a physiologically unique state of consciousness, characterized by decreases in respiration, oxygen consumption, carbon-dioxide elimination, heart rate and blood flow. They concluded that meditation is a wakeful hypometabolic physiological state. In 1975 Herbert Benson published his now famous study of meditation as 'relaxation response', which analyzed the effects of meditation and described a state of decreased arousal of the sympathetic nervous system, with decreased metabolism, breathing and heart rate, and decreased blood pressure (Benson, 1975, 1976, 1977). As an example of the extreme hypometabolic state induced by meditation, Kothari (1973) reported an EKG case study of Yogi Satyamurti who remained in a sealed box for seven days, during five of which he had no measurable heart beat; yet upon emerging from the box he had no noticeable adverse effects.

Studies of the effects of meditation on the levels of neurotransmitters regard meditation as a relaxation response that activates the brain's reward and motivation networks (pre-frontal and orbito-frontal cortex, cingulate gyrus, amygdala, hippocampus, and nucleus accumbens) through endogenous morphinergic signaling (Esch, Guarna, Bianchi et al., 2004). Other studies of the effects of meditation on neurotransmitters have found increases in the levels of

serotonin (Bujatti and Reiderer, 1976), dopamine (Kjear, Bertlesen, Piccini et al., 2002), and oxytocin (Unvas-Moberg, 1998). Increased levels of oxytocin have been found to increase the endogenous opioid activity, possibly contributing to the effects of relaxation response (Unvas-Moberg, 1998). However, other research has failed to find a causal relationship between opioid peptides and the overall EEG patterns during meditation (Sim & Tsoi, 1992).

These and other such studies point to meditation as a hypometabolic state, which with repeated practice leads to the establishing of internal metabolic rest as the baseline state of the organism (Young & Taylor, 1998). This finding, while applicable to most meditations, is not universal: a number of meditation techniques lead to heightened arousal. Furthermore, many relaxation inducing meditations techniques can become arousing in more advanced stages of practice (Peng, Mietus, Liu et al. 1999).

Gellhorn and Kiely (1972) attempted to explain these differences on the basis of how meditation influenced the autonomic nervous system. The authors concluded that meditation techniques could be classified as either ergotropic (energy expending) or trophotropic (energy conserving), depending on whether they activated sympathetic or parasympathetic nervous systems respectively, and that sufficiently intense stimulation of either system would lead to a "spill-over" effect where both autonomic systems were equally activated, thus giving rise to the unitary experiences characterized by intense bliss or ecstasy.

Other studies of the physiological effects of meditation have focused on the various aspects of general health that are affected by meditation. Over the past

twenty plus years, John Kabat-Zinn's team has produced a number of studies of the effects of mindfulness meditation, and his mindfulness-based-stress-reduction method (MBSR), on various health issues, focusing primarily on chronic pain management (Kabat-Zinn, 1982; Kabat-Zinn, Lipworth & Burney, 1985; Kabat-Zinn, Masson & Kristeller, 1992; Kabat-Zinn, Wheeler, Light et al. 1998). A recent study of the effects of mindfulness meditation on brain functioning and immune response among the workers of a biotechnology corporation, found pre-frontal lateralization characteristic of positive emotional states, and an increase in the immune response function (Davidson, Kabat-Zinn, Schumacher et al. 2003).

The effects of meditation on neuronal plasticity or, the ability of the brain to change anatomically in response to repeated experience, have been the focus of the most recent research on the physiological effects of meditation. In the first study of such kind, conducted by Sara Lazar at Harvard University and Massachusetts General Hospital (Lazar, Kerr, Wasserman et al., 2005), researchers found that meditation leads to an increase in cortical thickness in the areas involved in attention and sensation, especially in the right hemisphere. The increase in thickness was correlated with the overall length of meditation experience, most strongly in the inferior occipito-temporal cortex, making it unlikely that the finding was due to the natural tendency of meditators to have thicker cortex in those areas. However, the increase in cortical thickness has not been differentiated: it could mean an increase in the number of neurons or, an increase in dendrites, glial cells or in the cerebelar vasculature, all of which could contribute to a higher-functioning cortex (Lazar et al., 2005). Arguably the most

significant finding of this study was a decrease of age-related cortical thinning in the pre-frontal cortex (BA9/10).

The effects of meditation on EEG patterns have been extensively studied over the past fifty years. Increase and the forward spread of alpha waves has been the most universally reported signature of meditation (Baars, 2004). In addition, the appearance of rhythmic theta trains and their diffusion from frontal to posterior channels, together with the synchronization of anterior and posterior channels, have been found to correlate with deeper stages of meditation (Banquet, 1973). The early classic EEG studies of meditation conducted by Adand, Chhina and Singh in India, and by Kasamatsu and Hirai in Japan, underscored the differences between the absorption style of meditation (Sansk. *samadhi*), where the attention is focused on a single object to the exclusion of all other experiences, and the open-ended attention style of meditation (Jap. *zazen*), where the attention is evenly spread and all experiences are allowed to arise and pass of their own accord. Adand, Chhina and Singh (1961) studied a small group of highly experienced raja yogis during absorption meditation, subjecting them to a variety of auditory, visual and tactile stimuli, such as: loud noises, bright lights, cold water, etc. The authors found that during meditation, the yogis had persistent strong alpha activity, indicating obliviousness to external stimuli, although when resting they exhibited normal alpha blocking in the presence of sensory stimuli. In contrast to this, Kasamatsu and Hirai (1969) study of Zen monks revealed that the experienced Zen meditators did not display the habituating response to stimuli, and showed repeated blocking of alpha waves with each new stimulus (auditory

click). In other words, Zen meditators experienced each repeating stimulus as if fresh and new. These early studies were conducted using a small number of highly experienced meditators in relatively uncontrolled field conditions. Later studies were unable to replicate these results and found no effect on alpha blocking from different styles of meditation (Becker & Shapiro, 1981).

However, different EEG patters have been found with different meditation styles. Dunn, Hartigan and Mikulas (1999) found differences in the EEG amplitude between concentration meditators (focused attention), mindfulness meditators (evenly spread attention), and the control relaxation group (wandering attention). Greater amplitudes of delta and theta waves were found in the relaxation group, and the opposite in the higher frequency ranges. There were differences in EEG patterns between concentration and mindfulness meditations as well. Mindfulness resulted in increased delta, theta, alpha and beta1 activity, while concentration resulted in higher beta 2 activity. The authors concluded that these results indicate that mindfulness and concentration are states of consciousness significantly different from relaxation.

Increase in the frontal midline theta amplitude is a frequently observed effect of meditation (Cahn & Polich, in press). Studies of Qi Gong meditators showed that it is related to intense concentration and the recruitment of the anterior cingulated cortex, the medial pre-frontal cortex, and the dorso-lateral pre-frontal cortex (Cahn & Polich, in press; Pan et al., 1994).

Recent studies have also found differences in the EEG patterns related to different phases of the same meditation technique. The visualization and mantra

phases of the deity-yoga meditation resulted in the increase in gamma spectrum in the right posterior occipital and left temporal areas, while the self-dissolution phase of deity-yoga meditation resulted in the increase of gamma in the right superior pre-frontal area (Lehmann et al. 2001). Increases in high-end gamma spectrum over lateral pre-frontal and parietal areas were found during non-referential compassion meditation (Lutz et al., 2004). Furthermore, the amplitude of coherent high-end gamma waves was found to correlate with the subjective reports by the meditators of the perceived internal luminosity or brightness of consciousness (Davidson, 2005b).

Physiological studies of meditation indicate that meditation affects a wide variety of physiological markers, such as oxygen consumption and carbon-dioxide output, heart rate, blood pressure, skin galvanic response, neurotransmitter levels and the EEG patterns. Furthermore, different styles of meditation, different phases of the same meditation technique, and the overall length of meditation experience, all differentially affect the physiological markers. It appears that most of the observed effects are due to the modulation of attentional mechanisms, involving the pre-frontal, anterior cingulate and the parietal areas of the brain (Cahn & Polich, in press). Finally, the most significant recent finding has been the effect of meditation on neuronal plasticity.

Effects of Meditation on Emotions

Until recently, the majority of the studies researching the effects of meditation on emotions have focused on the effects of meditation on reducing

anxiety. Only recently has the focus shifted to studying compassion as an optimal state of being. The studies of compassion will be reviewed later, in the section examining Richard Davidson's work.

The studies of the effects of meditation on anxiety show that meditation significantly reduces anxiety (Delmonte, 1985; Kabat-Zinn et al., 1992). These effects may be based on the subject's locus of control: those with higher internal locus of control benefit more from meditation then those with an external locus of control (Beiman, Johnson, Puente et al., 1984). Meditations involving cognitive activities, such as repeating a mantra, may have greater effect on cognitive aspects of anxiety, while those involving somatic activity, such as attending to sensations of breathing, may have more effect on somatic aspects of anxiety (Davidson and Schwartz, 1984).

However, a question remains whether meditation is more effective than any other technique. For example, both meditation and hypnosis are equally effective in reducing state anxiety, but meditation is more effective in reducing trait anxiety (Edwards, 1991). Other studies found no difference between meditation and hypnosis in reducing anxiety (Benson, Frankel and Apfel, 1978). Smith (1975) conducted a controlled study attempting to isolate the effects of TM techniques on reducing trait anxiety from the effects of just sitting, and from the expectations of relief. The findings indicated that the therapeutic effect of TM on anxiety is not the result of the TM technique.

From the studies of the effects of meditation on emotions a conclusion can be drawn that meditation practice leads to decrease in anxiety; however, what exact aspect of meditation is responsible for this effect is not yet clear.

Effects of Meditation on Cognition

A number of studies have examined the effects of meditation on various aspects of cognition, such as perceptual skills, attention, cognitive styles, and intelligence (Murphy & Donovan, 1999). These studies have found that meditation affects perception by decreasing the perceptual threshold, so that one becomes aware of the usually pre-attentive perceptual processes (Brown, Forte & Dysart, 1984), and that it increases alertness, resulting in faster reaction times (Holt, Caruso & Riley, 1978). Carter, Presti, Callistemon et al. (2005), compared the effects of compassion meditation, described as "a non-referential contemplation of suffering within the world combined with the emanation of loving kindness" (Carter et al. 2005, p. 412), and one-pointed meditation, where the focus of attention was maintained on a single object, on binocular rivalry and motion induced blindness. The study found that the focused style of meditation resulted in the extension of binocular rivalry dominance and an increase in duration of motion induced disappearance.

Deikman (1966), after conducting some of the earliest phenomenological studies of the effects of meditation on perception, postulated that meditation leads to de-automatization and to a psychological regression to an earlier age of childhood or infancy, where the primary processes dominate, resulting in the

experiences of oneness and of intense realness. Wilber (2000a) however, has argued that this interpretation conflates the pre-rational or pre-personal stages, with post-rational or transpersonal stages of human development.

Other studies have shown that meditation has an effect on attention. Practice of meditation leads to increase in the attentional absorption, in direct proportion to the length of practice. (Davidson, Goleman & Schwartz, 1976). Mindfulness or, open-ended attention style of meditation, increases accuracy in responding to unexpected stimuli (Valentine and Sweet, 1999). Transcendental meditation or TM, increases the speed and accuracy on Stroop Color and Word Test and the Embedded Picture Test (Rani and Rao, 2001). These effects are not attributable to the religious beliefs surrounding the practice of meditation. A recent study of a secular form of meditation by Wenk-Sormaz (2005) attempted to eliminate subjective bias by using a non-religious meditation consisting of paying attention to one's breath. The author found that meditation increased attentional processes and decreased habitual responding.

Arguably the most studied feature of cognition, in terms of meditation effects, has been field-independence. Since meditation instigates a change in the ability to deploy attention, it has been expected that it would also lead to the increase in field-independence. Indeed, a number of studies have found this (Linden, 1973; Jedrczak and Clemens, 1984; Pelletier, 1974; Sridevi and Rao, 2003). In addition, in a controlled study of the effects of TM on perceptual-motor speed and nonverbal intelligence, Jedrczak et al. (1986) found higher performance

in the subject group that practiced meditation. The age of the subjects, however, was negatively correlated with performance.

While most of the studies of the effects of meditation on cognition tested only the short-term effects, few studies have attempted to find a long-term effect. Orme-Johnson and So, (2001) examined the long-term effects of Transcendental Meditation [TM] (repeating a mantra without fixed focus of attention or effort). Results showed that the practice of TM improved scores on all tests administered, while napping for the same duration had no effect. In contrast, contemplation meditation improved only results on inspection times and embedded figures. Researchers concluded that the cognitive and affective improvements are due to TM technique and not to merely resting. However, a review of randomized controlled trials by Canter and Ernst (2003) found that long-term cognitive improvements could be ascribed to the expectation effect, rather then to the practice of TM.

The studies of the effects of meditation on cognitive abilities demonstrate that meditation has an overall positive effect on cognitive processing, most likely due to the development of attentional expertise, which requires a considerable recruitment of the brain's attentional networks. While concerns can be raised in respect to methodological issues, such as experiment design, control groups and bias in self-reports, the majority of meditation studies testify to a number of effects and therapeutic benefits of meditation (Walsh, 1996).

Advanced research techniques

The development of modern scanning technologies PET, SPECT, MEG and especially fMRI in the past ten or so years, all of which can supply less ambiguous data, has ushered a new era in meditation research, focused primarily on the neural correlates of meditation. These studies have found activations in a wide variety of cortical and subcortical areas. However, the variety of results indicates that the most important issue for the research of meditation at present time is the careful accounting and systematizing of the different meditation styles and techniques across traditions.

In the Lou, Kjaer, Friberg et al. (1999) study of meditation and the resting state of normal consciousness, conducted using the PET method, the researchers played a tape of guided meditation involving the Yoga-Nidra type of relaxation, followed by a guided imagery exercise on the archetype of the self. Lou and his colleagues found decreases in functioning of both the dorsolateral prefrontal cortex and the anterior cingulate cortex, which they associated with the relinquishing of executive activity, and they compared it with the similar lack during sleep. The supplemental motor area, together with the parietal and occipital areas, was activated during the body relaxation meditation; the left temporal area, and especially Wernicke's area, was activated during the meditation on positive emotions—indicating the highly conceptual-verbal nature of this experience; and the visual and parietal areas were activated during the imaginary tasks portion, with the notable exception of the primary visual area. The researchers noted bilateral parietal activity during the symbolic meditation on

the self. They concluded that "the meditative state is characterized by the activity in the hippocampi and posterior sensory and associative areas known to be activated by imagery, and the resting state of normal consciousness is, when compared to meditation, characterized by activity in the executive attentional system and the cerebellum" (Lou et al., 1999, p. 104).

As can be seen by this summary, a central problem arises out of not recognizing the importance of classifying different states of meditation: researchers generalize results obtained with a very specialized type of meditation and erroneously apply them to all meditative states of consciousness.

In 2000 Lazar, Bush, Gollub et al. published the very first fMRI study of meditation, conducted at the Mind-Body Medical Institute and at Massachusetts General Hospital. The subjects engaged in a Kundalini Yoga type of meditation, repeating a mantra with each inhale and exhale while observing their breath. In contrast to the above-mentioned study by Lou et al., this study found that meditation leads to increased activity in the dorsolateral prefrontal cortex, the anterior cingulate gyrus and parts of the parietal cortex, which are involved in the focusing of attention. The study also found activations in the amygdala, midbrain, hypothalamus and hippocampus/parahippocampus in the majority of subjects, which are structures associated with the control of the autonomic nervous system, and a decrease in the overall metabolic rate and blood flow to the entire brain, characteristic of all absorption-style meditations (Lazar et al., 2000).

The findings of the activations in the temporal lobe are most likely related to the verbal nature of meditation, i.e. the mantra repetition. The meditation

technique using a mantra and focusing attention on one's breath determine, in this case, the areas of the brain showing more activation—those involved in internal speech and maintaining focused attention. The question is to what extent these findings represent neural correlates of meditation, rather than the neural correlates of processes that eventually lead one into the meditative state.

In investigating the basic Zen meditation of focusing on breathing and counting one's breaths from one to ten, Baerentsen and his colleagues (2001 and 2004), using fMRI, found a general increase in activation of the frontal cortical area and several subcortical areas. In particular, according to them, the onset of meditation seems to correlate with increased activation of the left frontal, anterior cingulate, and inferior parietal areas, the right superior temporal gyrus and the hippocampus, while deactivation was found in the posterior cingulate cortex and parts of the left prefrontal cortex related to thinking – and in the primary motor cortex. Their later study (2004) of the same meditation technique found activations in a number of different areas: the right superior temporal gyrus, the right putamen, the unspecific and somatosensory nuclei of the thalamus, the bilateral cingulate gyrus, bilateral superior, and medial frontal gyrus, the right inferior frontal gyrus, and bilateral paracentral gyrus. They found deactivations in the left cerebellum, sections of the anterior cingulate gyrus, the left parahippocampal gyrus, the left superior, middle, medial, and inferior frontal gyrus, the left superior and middle temporal lobe, the fusiform gyrus, the left inferior parietal lobe, and the angular and supramarginal gyri (Baerentsen, Hartmann, Green et al. 2004). The authors concluded that these findings further

support the outcome of their 2001 study—that the subcortical areas of the brain play the role of a neuronal switch, allowing for the transition from the normal state of consciousness to one of a meditative state of consciousness.

However, a question can be raised as to whether all of the activations found through the use of these new imaging techniques are due to the meditative state of consciousness alone, since the brain at rest generates a considerable amount of noise due to the spontaneous activity of its anti-correlated, globally distributed neuronal networks (Fox, Snyder, Vincent et al., 2005).

I will address this issue in more detail in the analysis section.

The Nature of Meditative Consciousness

Rather then studying the effects of meditation, the central theme of this group of research is the nature of meditative consciousness itself. Because this topic has more direct bearing on my own research then the previous three categories, I will review it in greater depth. The research on the nature of meditative consciousness includes: the research on pure consciousness, conducted by Fred Travis and his colleagues at Maharishi's University of Management in Iowa; research on absolute unitary being, conducted by Andrew Newberg and his partner, the late Eugene D'Aquili, at the University of Pennsylvania; research on compassion, conducted by Richard Davidson and his group at the University of Wisconsin; and the research of Zen meditation, by James Austin from the University of Colorado. (I will say briefly what these terms mean below in the corresponding sections of the review, then in more depth in the review of

literature on Asian nondual philosophies.). In addition to these researchers, there are probably several more teams currently conducting research on the nature of meditative consciousness, including my team at Rutgers University in New Jersey, whose findings have not yet been published.

Research of Pure Consciousness

Deikman (1996) describes pure consciousness, which he equates with awareness, as "the ground of all experience" and writes: "Awareness is something apart from, and different from, all that of which we are aware: thoughts, emotions, images, sensations, desires and memory. Awareness is the ground in which the mind's contents manifest themselves; they appear in it and disappear once again" (p. 350).

The followers of Maharishi Mahesh Yogi are so far the largest source of the research on pure consciousness. The two researchers most relevant to the present study are Fred Travis and Alarik Arenander. Travis states that: "Pure consciousness is pure in the sense that it is free from the processes and contents of knowing " (Travis & Pearson, 2000, p. 79).

In phenomenologically researching TM subjects who have had the experience of pure consciousness on a regular basis, Travis notes that they report being peaceful, unbounded, and without a sense of space, time or body. Here he quotes an experienced TM practitioner: "The flurry of waking activity comes and goes; the inertia of sleep comes and goes. Yet, throughout these changing values

of waking and sleeping, there is a silent, unbounded continuum of awareness that is me; I am never lost to myself" (Travis, 2003, p. 3).

Experiencing pure consciousness during TM meditation has been correlated with periods of decreased metabolic rate, high cortical coherence, and spontaneous respiratory suspensions. Spontaneous suspension of breath (Sansk. *khevalakumbhaka*) occurs periodically, and subjects exhibit decreased sensitivity to CO_2 and increased sensitivity to O_2. Hypothetically, this is a result of an active inhibitory mechanism acting upon the brain stem respiratory centers, rather than a passive response to reduced metabolism, even though a decreased metabolic rate plays a contributing role (Arenander, 1996; Travis, 2001). In addition, regional blood flow becomes altered with decreases in hepatic and renal flow and increases in brain blood flow. Both heart rate and plasma cortisol levels decrease. High levels of distributed EEG alpha activity, with frontal and central theta, together with beta spindle bursts, characterize TM meditation. The alpha activity usually appears first in frontal regions and then spreads to posterior regions. There is also high amplitude theta activity, which is different from sleep-onset synchronous activity. A de-excited state with awareness maintained apparently manifests in changing coefficients of wakefulness and activation. In other words, the meditator is more awake than normal, with less mental activity occurring. Increases in inter- and intra-hemispheric synchrony and coherence of EEG signals, especially in the 40 Hz range, have also been noticed (Arenander, 1996).

TM researchers have established the following parameters which they believe indicate when a subject is experiencing pure consciousness during

meditation. The indicators are: 1) effortless and spontaneous suspension of breathing; 2) change in skin conductance (autonomic orientation) at the onset of breathing changes; and 3) increase in the frequency of peak EEG power, attributed to the increased alertness during experiences of pure consciousness.

These and other findings have led Travis (1994) to propose a model of consciousness he calls the "junction point model," which is also based on interpretation of Vedanta, especially that of the Mandukyo Upanishad, according to the TM system of Maharshi Mahesh Yogi. This model "portrays waking, NREM-sleep, and REM-dreaming as expressions of a single undifferentiated state… In the transitions between waking, NREM-sleep and REM-dreaming, bursts of similar frequency EEG – 7 to 9 HZ – are seen that do not seem generated by the known sleep mechanisms, suggesting a common experience available in these transitions…" (Travis, 1994, p. 91).

In addition to well-known EEG patterns reflecting the three distinct stages of waking, dreaming and dreamless sleep, Travis noticed 7-9 Hz activity occurring at the transition points from one state to another. He believes that these theta-alpha bursts correspond to the moments of pure consciousness occurring during these transitions, and that they indicate an ongoing substratum underlying the three states of consciousness. In this sense, he upholds the Vedantic distinction between the nature of consciousness and its states.

Furthermore, his research shows that one can intentionally experience pure consciousness, and that it can be maintained throughout the three changing states of waking, dreaming and deep sleep. Travis attributes the longer duration of 7-9

Hz bursts during TM to the fact that "one continues to give inward direction to awareness, thereby cycling through transcendental consciousness many times in each session, in contrast to the transition through that state in the shift from waking to sleeping" (1994, p. 99).

Travis also reports that the theta-alpha bursts seen in advanced TM meditators while they were in the state of sleep, superimposed on the delta activity, indicated what is known as "witnessing sleep." The junction point model accounts for both the subjective experience of being aware while physically sleeping and the objective results of the simultaneous presence of theta-alpha waves with delta waves. He hypothesizes that the presence of both cortically originating delta and cortically and sub-cortically originating alpha-theta waves indicates that distinct brain wave generators might have become coupled to produce this state (Travis, 1994, 2003).

In defining the difference between lucidity and witnessing during dreaming, Travis states that in witnessing, there is a quality of a steady separate self who is silently observing but not influencing the dream, whereas during lucid dreaming, the subject feels involved in the dream and does not experience himself as separate. He sees this as a sign of meta-cognition during lucid dreaming and points to studies by Gackenbach (1985) that showed that lucid dreamers have a higher capacity for observing their daily experiences, as well. It is important to note, however, that pure consciousness is not meta-cognition, because it is not a conceptual process of thinking about something or even reflecting on the process of thinking. Rather, it is consciousness resting in its own nature.

Experienced TM meditators show a change in the patterns of functioning of the frontal lobes, such as the forward spread of alpha waves into the frontal areas, which is associated with an increased sense of the presence of a witnessing self. The increase in frontal lobe EEG coherence suggests "greater functional co-ordination of the frontal circuits involved in the neuronal implementation of one's self-model" (Travis, Tecce, Arenander & Wallace, 2002). Travis and his colleagues regard the experience of pure consciousness primarily as the alpha band coherence in the frontal lobes.

In hypothesizing what might be the causes of observed synchrony, Travis writes:

> First, prefrontal and basal forebrain areas act as a "neural switch" to inhibit thalamocortical activity. This leads to the reduced levels of mental activity without loss of self-awareness — a "de-excited" state of mind and body. Second, cortico-basal ganglia-thalamocortical (CBGT) oscillations, which modulate cortical excitability and sequencing of cortical events, maintain this de-excited state (Travis et al., 2002, p. 312).

Of the five parallel CBGT loops that are known, Travis sees the two originating in pre-motor and parietal multimodal sensory areas as not being involved in meditation, due to the motionless posture of meditation. The remaining three loops, which originate in the dorsal-lateral frontal, orbito-frontal and anterior cingulated cortices, are believed to modulate attention allocation, emotional tone, and activation of self-beliefs. Travis states that the TM technique

allows these three CBGT loops to maintain resting rhythms of oscillations that facilitate mental and physical de-excitation. In addition, he believes that these CBGT modules become self-sustaining during TM practice and co-exist with sensory processing during waking consciousness (Travis et al., 2002; Travis & Wallace, 1999).

Another TM researcher, Alarik Arenander, on the other hand, focuses primarily on the experience of pure consciousness alone, and on the transition from waking consciousness to pure consciousness during meditation. He uses the term "transcending" to describe the entire process of TM, which consists of mantra repetition and progressing through increasingly more quiet levels of mind until stillness of pure consciousness is reached – then again applying the mantra repetition when one is out of pure consciousness and in thinking mind. However, the term "transcending" is somewhat imprecise from the standpoint of finding the neural correlate of pure consciousness, as it embraces both the conceptual level of the mind, the practice of mantra repetition, and the result of that practice – pure consciousness.

Arenander (1996) sees the neural correlates of TM meditation and the subsequent pure consciousness in the context of alteration of distributed neural network activity, rather than in the functioning of any particular brain structure. His model proposes that the mechanisms for selective attention are joined with the mechanisms for orienting and habituating in such a way that maintaining focused attention leads to habituation and increase in de-excitation, while the local and global orienting mechanisms sustain the conscious awareness (Arenander, 1996).

He outlines the functioning of five neural substrates involved in supporting the experience of TM: 1) the thalamocortical system, which includes the nuclei of the thalamus that regulate the overall state of consciousness; 2) inhibitory and excitatory systems located in the basal forebrain and the reticular formation, respectively; 3) the prefrontal cortex and its attentional system; 4) the amygdala and the limbic motivational system; and 5) the locus coeruleus, which influences the global state of the brain and its information processing. Each neural substrate is described in more detail below.

The thalamocortical system. "The exchange of information within and between the thalamic nuclei and the various areas of the cerebral cortex is the most probable neural substrate for the human cognitive activities of thought development and conscious experiences" (Arenander, 1996, p. 6). During TM, the thalamocortical system becomes itself transformed so as to be able to sustain the heightened experience of consciousness characterized by the high amplitude and low frequency EEG, which, unlike in normal conditions, does not signify falling asleep. Rather, what distinguishes the experience is the coherence and connectivity of the oscillating thalamocortical loops. Arenander believes that this is accomplished through the simultaneous action of opposing neural modalities, cultivated through focusing the attention on the mantra, so that the competing external and internal stimuli fail to gain access to the central processing system. The loss of the sense of space and time during absorption is attributed to the entire synaptic pool being dedicated to processing a single stimulus, leading to decreased arousal and increased sensitivity. Arenander (1996) thinks that this

occurrence may be accomplished via thalamocortical feedback loops instigated through inhibitory activity of the reticular nucleus of the thalamus. This activity, when extended over time, institutes a re-organization of the brain consisting of a more distributed and integrated functioning – that is, a global synchrony – which he sees as the prerequisite for the experience of pure consciousness.

Inhibitory and excitatory systems. The overall level of thalamocortical activity and one's waking and sleeping cycles, are influenced by the excitatory activity of the mesencephalic reticular formation and the inhibitory activity of the basal forebrain system, converging onto the intralaminar and reticular nuclei of the thalamus through the action of the hippocampal-based comparator system (Arenander, 1996). Meditation posture and method activate both the inhibitory system, which leads to de-excitation, and the excitatory system, which maintains alertness. The hippocampal-based comparator controls their balance through an ongoing match-mismatch analysis of the orienting reflex (i.e. "What is it?"), which is provided by the repetition of the mantra. A match increases inhibition and relaxation, and a mismatch increases excitation and alertness. Since the TM technique is essentially an absorption (Sansk. samadhi) type of meditation, inhibitory function increases gradually, leading to the repeated activation of the orienting reflex, thus maintaining the excitation necessary for the global synchronous state to arise.

The prefrontal cortex system. The prefrontal cortex provides the control necessary to carry out the process of focusing on the mantra during the time of a meditation session. This steady, repeated focus prevents both the arising of

excessive thoughts and the drifting off into daydreaming and sleep. During the time that one is experiencing pure consciousness (assessed on the basis of spontaneous suspension of breath between one and 60 seconds in duration and which occurs up to several times during one meditation session), the prefrontal cortex exercises a complete suppression of all external and internal experiences. Arenander writes:

> Probably the most critical function mediated by the prefrontal cortex activity lies in bridging the unique discontinuity or "gap" in conscious experience that begins in the final step of the "transcending." Since Transcendental Consciousness [pure consciousness] is characterized by a complete lack of any object of attention and any space-time boundaries, the cognitive apparatus must be capable of bridging this transition from bounded to unbounded and back to bounded states. The orderly sequence of repeatedly entering and emerging from the self-referral state of brain and consciousness that occurs during the practice of the TM technique must represent the most abstract transformation of the attentional mechanism. (Arenander, 1996, p. 10)

The amygdala and the limbic motivational system. This system is responsible for attaching emotional significance to our experiences. Since meditation practice, once mastered, is a pleasurable activity leading to an increase in physical and psychological well-being, Arenander (1996) postulates that the amygdala is involved in: 1) increasing motivation by relaying processing from the neocortex to the hypothalamus and the basal forebrain; 2) completing the

prefrontal-amygdala-dorsomedial thalamus-prefrontal loop that processes the relevance of stimuli such as a mantra; and 3) transferring these cognitive events into autonomic and respiratory responses via the inhibitory and excitatory systems.

The question however remains as to which neural structures subserve the different qualities of pure consciousness. One of the main characteristics of pure consciousness is bliss. Even when consciousness is isolated from experience, as is the case with pure consciousness, bliss – which is an emotional potentiality – is still present. This means that the dorso-lateral-prefrontal cortex and possibly limbic system and the amygdala could be involved in pure consciousness beyond their functioning during the mantra stage of meditation.

The locus ceruleus. Noradrenergic cells of the locus ceruleus exercise global control of information processing. During TM, they affect the brain in two ways. First, they "bias the responsiveness of the thalamocortical system towards processing the focus of attention and suppressing the other competing stimuli and distracting activities"(Arenander, 1996, p. 12). Second, they change cortical plasticity, modifying neuronal connectivity, in such a way as to stabilize the consciousness generated during TM. In this process, pre-conscious cognitive activity becomes stabilized and can be experienced during the waking state of consciousness.

It is not clear in Arenander's model in which way he sees pure consciousness as being pre-conscious during TM meditation. Pure consciousness is self-knowing, so once established or self-recognized, it cannot be pre-

conscious. However, through extending the idea of neuronal plasticity, Arenander arrives at his understanding of the neural correlate of nondual awareness. He believes that in advanced stages of meditation pure consciousness is experienced together with waking consciousness indicating that the neuronal functioning is able to mediate both of these states at the same time. He refers to this new state as the fifth unique state, that of enlightenment (Arenander, 1996).

This fifth state of consciousness corresponds to the nondual awareness, the main focus of this study. However, it is not entirely accurate to regard pure consciousness and nondual awareness as separate states that are different from the three ordinary states of waking, dreaming and deep sleep, because they are not actually states in themselves. Rather, as the review of Asian philosophy will show, they are the nature of consciousness itself, distinct from various states and functions of consciousness.

A significant issue arising from TM research is whether pure consciousness is a result of neuronal entrainment. But progressing toward pure consciousness, and subsequently nondual awareness, is not only a matter of conditioning. As argued extensively in the Asian nondual traditions, pure consciousness is not a result that can be created by the activity of the intentional mind, which is its derivative. Thus the possible signature brain states of pure consciousness and of nondual awareness, such as the synchronous 7-9 Hz alpha-theta oscillations, must in some way be latent and exercise background influence over the more disorganized states – propelling them, however faintly, toward organization in higher states of coherence. In this sense, meditation can be seen as

an expression of the optimizing impulse of pure consciousness directed towards its self-recognition.

Studies of the Absolute Unitary Being

Andrew Newberg and his late partner Eugene D'Aquili (1999, 2000, 2002) have also conducted research on pure consciousness, calling it the absolute unitary being. What distinguishes their research is that instead of focusing on meditation techniques exclusively, they also consider the larger picture that includes other religious and mystical experiences. They conclude that: there are two groups of religious practices that induce unitary experiences—ritual and meditation; ritual being a bottom-up activation of the brain and the meditation the top-down activation—with both ending in the same place. Ritual, while being the more accessible of the two, is not as potent (D'Aquili, 1978). They describe the realization of pure consciousness during meditation in this way: "In the most profound unitary states, a person loses all sense of discrete being and even the difference between self and other is obliterated. There is no sense of passing of time, and all that remains is a perfect timeless undifferentiated consciousness" (Newberg & D'Aquili, 2002, p. 263). Elsewhere, they define the absolute unitary being as follows:

> The transcendent state we call Absolute Unitary Being refers to states known by various names in different cultures--the Tao, Nirvana, the Unio Mystica, Brahman-Atman--but which every persuasion describes in strikingly similar terms. It is a state of pure awareness, a clear vivid

> consciousness of no-thing. Yet it is also a sudden, vivid consciousness of everything as an undifferentiated whole. (Newberg, Alavi, Baime et al. 2001, p. 147)

The above paragraph seems to indicate a conflation of the idea of pure consciousness with that of nondual awareness, that is with pure consciousness operating with experience. As can be seen below, this poses a problem in interpreting activations and de-activations in the parital lobe.

D'Aquili and Newberg base their theories about how the brain functions during meditation on three key concepts: ergotropic-trophotropic functioning of the autonomous nervous system, the mechanism of neuronal deafferentation, and the role of cognitive operators.

As mentioned above, the ergotropic-trophotropic theory of Gelhorn and Kiely (1972) sees the function of the autonomic nervous system as either ergotropic (energy expending) or trophotropic (energy conserving). The first one is the sympathetic part of the autonomic nervous system, which is involved in hyper-arousal and the "fight-or-flight" response. The second one is parasympathetic part of the autonomic nervous system, which is involved in hypo-arousal and the "rest-and-digest" response.

D' Aquili and Newberg (1999, 2002) apply this theory to meditation and to religious experiences in general, and they postulate that the sympathetic system is activated in religious practices that rely on increasing stimulation and excitation, while the parasympathetic is activated in those practices that decrease

stimulation and lead to mental quiescence. While the two systems usually function in opposition to each other, according to ergotropic-trophotropic theory they can trigger each other, so that at the height of arousal due to sympathetic functioning, there can be a "spill-over" into the parasympathetic system—leading to the experience of oneness, marked by extraordinary calmness and lucidity.

Newberg (2000) develops the idea of five states of autonomic system functioning as related to spiritual experiences: a) the hypertrophotropic, which occurs in mental quiescence and sleep; b) the hyperergotropic, which is the state of extraordinary alertness and focus which they compare to Czikszentmihalyi's concept of "flow"; c) the hypertrophotropic state with ergotropic eruption, which occurs as energy releases and insights emerge from within the state of deep absorption; d) the hyperergotropic state with trophotropic eruption, mentioned above as quiscence within arousal, which authors compare to orgasm and ecstatic and trance states; and e) the maximum simultaneous stimulation of both ergotropic and trophotropic systems, which the authors believe is involved with the most profound mystical experiences.

Newberg and D'Aquili define deafferentation as "the ability of certain brain structures to block the input into other structures....When a brain structure that ordinarily processes input has been deafferented to a significant degree, the structure is required to function upon its own random neuronal activity..."(Newberg, 2000, p. 258). An example of deafferentation they give is a visual area of the cortex to which input has been blocked, thus resulting in its

interpreting random neuronal activity as visual content, and giving rise to hallucinations.

Newberg and D'Aquili coined the term *cognitive operator* to describe a specific function of the brain that goes beyond distinct neuronal areas. "Cognitive operators refer to general methods or functions by which the brain interprets the world" (Newberg, 2000, p. 253). Their functions include the processing of sensory data, the establishing of spatial and temporal context, connecting various aspects of experience into causal structures which gives rise to self-world maps and views, etc. D'Aquili and Newberg (1999, 2002) identify seven cognitive operators: a) the holistic operator that perceives whole gestalts—situated in the right/non-dominant superior posterior parietal lobule; b) the reductionist operator that perceives elements within gestalt; c) the abstractive operator that creates taxonomies and correlates data into theories—which they ascribe to the left parietal lobe; d) the quantitative operator that performs mathematical functions; e) the causal operator that performs cause and effect sequencing; f) the binary operator that organizes reality in terms of pairs of opposites—which they ascribe to the inferior parietal lobe; and g) the existential operator that determines whether something is real or not. The two cognitive operators most relevant to spiritual experiences are the causal operator—which in the absence of a first cause in a chain projects a point of origin, such as God—and the holistic operator—which is capable of viewing reality as a whole, and which in the absence of input creates a sense of timeless wholeness.

D'Aquili and Newberg (1999, 2000) further identify four associative areas of the brain as being significant in understanding spiritual experiences. First, the *posterior superior parietal lobule* (PSPL) is involved in egocentric perspective and in establishing the three dimensional sense of a body in space. The right PSPL creates a sense of location and spatial coordinates, while the left PSPL is involved with immediately graspable objects. They hypothesize that the difference between what is graspable and what is not may be the basis of the self-other boundary. Interestingly, this idea differs from generally accepted ideas in developmental and transpersonal psychology which see the self-other boundary as a development of the inside-outside boundary defined by the skin (Josipovic, 1990). Second, the *inferior temporal lobe* (ITL) is involved in object identification and is also known as the "what-pathway." Third, the *inferior parietal lobule* (IPL) Newberg and D'Aquili call the "association area of association areas" because of its function in integrating visual, auditory and somatosensory associations. They see it as being involved in a "generation of abstract concepts and relating them to words" (2000, p. 258). Fourth, the *pre-frontal cortex* (PFC) is involved with intention, planning, control and will.

The centerpiece of Newberg and D'Aquili's study was their SPECT scan of Tibetan Buddhist meditators involved in a concentration type of meditation focusing on a visual image (Newberg et al. 2001). They reported increases in brain activity in the pre-frontal cortex consistent with focusing attention on a visualized image during meditation. Concomitant with this, they found decreased

activity in the ipsolateral area of the superior posterior parietal lobule, indicating a possible differentiation of this area by the dorso-lateral PFC.

The technique used by their subjects was to focus on an image, which led, over the course of the meditation session, to the state of absorption and isolation of consciousness from experiences. The progressive mechanism believed to mediate this process involves an initial increase in activity of the pre-frontal cortex (PFC), which leads via the thalamus to the an increase in activity of the posterior superior parietal lobule (PSPL)—the function of which here is to provide the orienting context for the visual object presented by the inferior temporal lobe (ITL).

Newberg and D'Aquili (2002) also believe that reverberating loops have a central role in mediating meditation as a process. However, they see the loops as primarily involving the hypothalamus, in addition to the structure mentioned above. The involvement of the hypothalamus and, to some extent, the amygdala provides the background feeling of pleasure in meditation and activates the ergotropic-trophotropic mechanism of the hypothalamus, leading to the maximal activation of both. This activates the PFC to such an extent that the left PFC induces a complete blocking of the left PSPL, which they associate with the loss of subject-object boundary, and which the meditator experiences as becoming one with the object of meditation. On the right side, however, the blocking of the right PSPL by the right PFC is interfered with by the activity of the ITL maintaining the presence of the object being visualized. Maintaining this state of maximal ergotropic-trophotropic activation eventually leads to a breakthrough, as the

meditator lets go of control and the right PFC totally blocks the right PSPL, with the concomitant loss of the sense of space and time. "Thus, the end point of the meditation is maximal stimulation of ergotropic and trophotropic systems with total blocking of input into both the right and left PSPL, resulting in the most profound unitary state attainable" (Newberg, 2000, p. 261).

In attempting to understand how this unitary state may be one of pure consciousness, they speculate that it is the activity of the left pre-frontal cortex that makes it possible for "the state of undifferentiated unity [to] actually be experienced as one of intense consciousness" (ibid, p. 263). Their discussion of the differences in the states generated through deafferentation of only the left PSPL versus deafferentation of both the left and right PSPL is rather significant. Deafferentation of only the left PSPL leads to states of Unio Mystica or union with God, which is the loss of the self-other boundary and the absorption in the "other." In contrast, deafferentation of both PSPLs leads to an impersonal state of the Absolute Unitary Being (Newberg et al. 2001). They define this state as follows:

> There would be no discrete objects or beings, no sense of space or the passage of time, no line between the self and the rest of the universe. In fact there would be no subjective self at all; there would be only an absolute sense of unity—without thought, without words, and without sensations. The mind would exist without ego in the state of pure undifferentiated awareness. (Newberg et al. 2001, p. 120)

In the above passage, the researchers clearly indicate pure consciousness. However, later, in elaborating on the qualities of this state, they seem to arrive at a misunderstanding of nondual awareness when they state: "This awareness would be neurobiologically incapable of differentiating between subject and object, between the limited personal self and the external material world. It would perceive and interpret reality as a formless unified whole, with no limits, no substance, no beginning and no end" (ibid, p. 150).

This misunderstanding is due to conflating the states of pure consciousness and nondual awareness. The pure consciousness they describe does not differentiate subject from object when isolated because subject and object do not occur to it. It is pure and is thus without any objects from which the subject can set itself apart. On the other hand, nondual awareness (pure consciousness functioning with daily experiences) is not awareness that is incapable of differentiating. Rather, when cognized by the nondual awareness, the field of experience is simply not fragmented into subject and object by these reifying concepts.

Research on Compassion

Richard Davidson's group, which includes Matthieu Ricard, Antoine Lutz, John Dunne, Julie Brefczynski-Lewis and others, at Keck Laboratory, University of Wisconsin-Madison, researches the effects of meditation on cognitive and affective functions, and on the brain mechanisms that underlie these processes. Their aim is to further elucidate the nature of conscious experience as cultivated

by the Tibetan Buddhist meditations, in the hope that this will offer insight about the fundamental nature of consciousness (Davidson, 2004c). They base their meditation studies on Davidson's previous research into the neural substrates of affective states. Below, I briefly summarize these earlier findings [as well as generally accepted findings from other studies] in regard to areas of the brain that might be significant for meditation research.

The prefrontal cortex is termed the central executive committee, because of its role in planning and making decisions (Faw, 2003), as well as in establishing cognitive control (Miller, 2000). Some hypothesize that it functions by maintaining representations of goals and the means to achieve them (Miller & Cohen, 2001), and that it holds sensory information and memory on-line for processing (Wood & Grafman, 2003). Different unimodal association areas of the cortex located in the parietal, temporal and occipital lobes converge anatomically and functionally into the prefrontal cortex in order to enable the re-integration of the representations of self and world, and the implementation of self-monitoring (Vogeley, Kawasaki, Jung et al., 1996).

The middle frontal gyrus of the prefrontal cortex (BA 46) is possibly the site of abstract thinking (Snow, 2003). Davidson's research (2000) shows that the prefrontal cortex (PFC) plays a significant role in the experience of emotion, and in the experience of compassion and bliss generated through meditation. In particular, the *ventromedial sector* of the prefrontal cortex is involved in elementary positive and negative emotional states and in decision-making. In conjunction with the orbitofrontal cortex, it is involved in anticipating rewards or

punishments; the left medial orbitofrontal cortex relates to rewards, while the right lateral orbitofrontal cortex relates to punishment. The *dorsolateral sector* of the prefrontal cortex (DLPFC), on the other hand, may be involved in defining goals toward which more elementary emotional states are directed. Furthermore, there is a differentiation between the left and right DLPFC, so that positive emotion correlates with an increase in activity of the left DLPFC, and negative emotion correlates with an increase in activity of the right DLPFC (Davidson, 2000; Davidson, 2004a; Davidson & Irwin, 1999). This differentiation is perhaps due to the function of the left PFC in inhibiting the amygdala; however, the left PFC has also been associated with certain types of anger (Davidson, 2004a). A recent study confirms this prefrontal asymmetry, but the EEG readings reveal that it is primarily located in the superior regions of the PFC, rather than further forward in the dorsolateral area (Urry, Nitschke, Dolski et al., 2004). Also, the left regions of the prefrontal cortex appear to be involved with desirable goals, while the right side is involved with goals that require inhibition of other competing goals (Davidson, Pizzigalli, Nitschke & Putnam, 2002).

The anterior cingulate cortex has an important role in the mechanisms of attention, and in the monitoring of conflict in functioning between different regions of the brain. It also activates during the experience of emotions, especially as compared to the rest state. Some hypothesize that it plays a role in the effects that emotion has on attention, and that it serves as a bridge between emotion and attention (Davidson, 2000; Davidson & Irwin, 1999; Davidson et al., 2002). Hypoactivity in the dorsal anterior cingulate cortex characterizes depression, and

increased activity in the rostral anterior cingulate cortex indicates a good recovery prognosis (Pizzigalli et al., 2001). Decreased activity in the dorsal area of the anterior cingulate cortex relates to impaired attention allocation and response choice, while decreased activity in the ventral area relates to deadened affect, hypoarousal and anhedonia (Davidson et al., 2002).

The amygdala is involved in perceiving emotions in others and in responding emotionally. It particularly relates to the generation of the fear-anger response and to the coordination of cortical arousal and vigilance. Interestingly, researchers report both anatomical and functional changes in the amygdala in the case of emotional disorders and alcoholism. In addition, some postulate a role of the amygdala in chronically elevated anxiety as well (Davidson, 2000; Davidson & Irwin, 1999; Davidson et al., 2002; LeDoux, 2000).

As mentioned earlier in this section, the primary function of the hippocampus is to facilitate the formation of various types of memory, such as spatial, declarative, contextual, etc. Davidson et al. find that hippocampal dysfunction is involved in inappropriate context regulation of affect, and in the possible increase of chronic stress—through the reduction of its inhibitory role on the hypothalamus-pituitary-adrenal system (2002).

There is a large body of evidence linking the dopamine pathways in the ventral striatum (the caudate, putamen, and nucleus accumbens) to experiences of positive affect and addiction. Some also hypothesize that the dopamine system plays a role in the positive affect that arises as one progresses toward a desired goal (Davidson & Irwin, 1999).

The insular cortex is involved in visceral representation of emotional experience, probably due to its connections with the autonomic system and those regions of the brain that regulate it (Davidson & Irwin, 1999).

Current research of Davidson and his group focuses on four mental states arising in meditation (Davidson, 2004c): a) absorption or "one-pointed concentration;" b) nondual awareness (Tib. Rig-pa), which they also call "open attention" and define as a state of total openness in which the mind is not focused on any experience, and at the same time not intending to block or prevent any experience; c) visualization, which is a process of constructing and viewing elaborate mental images, and; d) compassion, which is an absorption into a compassionate and loving state of mind—the purpose of which is to counteract self-centered tendencies.

Their EEG study of advanced Tibetan Buddhist monks (including most notably their fellow researcher Matthieu Ricard), practicing a meditation on compassion in which they generated a non-conceptual and non-referential state of compassion, found a high-amplitude gamma synchrony both locally and globally, especially in the lateral fronto-parietal areas (Lutz, Greischar, Rawlings et al. 2004). There was an overall increase in gamma activity (25-42 Hz) compared to alpha and theta activity, and this increase was more significant for experienced meditators, suggesting that large-scale coordination of brain activity increases during meditation and with experience. For Matthieu Ricard in particular, the study measured the highest amplitude of gamma activity ever found in a subject

(80-120 Hz). "Assuming that the amplitude of gamma oscillations is related to the size of the oscillating neural population and the degree of precision with which they oscillate, these data suggest that massive distributed neural assemblies are synchronized with high temporal precision in the fast frequencies during this state" (Lutz et al., 2004, p. 16372).

These researchers also noticed that during the course of a single session of meditation, synchrony increases with time (the practitioners need 5-15 seconds to transition from the normal state into the meditative state), and they attribute this to an increase in temporal precision of the thalamocortical loops, and to an increase in the number of neurons and neural networks participating in the synchrony. Most importantly for this dissertation, they hypothesize that the synchrony in the gamma range reflects a fundamental change in awareness from ordinary dualistic awareness to nondual awareness.

In a recent study (Lutz, Brefczynski-Lewis & Davidson, 2004), the same type of meditation on compassion is examined using an fMRI. Increased activity in the left dorso-lateral pre-frontal cortex and deactivation of the same area on the right side was noticed, further confirming Davidson's previous research on prefrontal asymmetry during emotional experience (Davidson, 2004a). Also, increased activity was noticed both in the putamen and in the caudate which are involved in regulating physical motion – possibly indicating increased readiness to compassionately respond physically, such as found in the experience of maternal love.

Significant increases were also present in the anterior cingulate cortex and bilateral insula—in particular, the anterior part that mediates emotions, the somatosensory cortex and the cerebellum, all of which activate during the experience of pain. This leads to the conclusion that the areas involved in experiencing compassion toward another's pain are the same as the areas involved in experiencing our own pain. The prefrontal area related to working memory also showed increased activation in the subject group versus the control group, while decreased activation was found in the right inferior parietal cortex, which has been linked to mediating social interactions and self-referential perspectives, indicating that a more holistic state of oneness occurs during an experience of nonreferential compassion. "The data suggests that this meditative state [of compassion] is mediated by brain functions involved in positive emotions and maternal love, motor actions and empathy. The group difference suggests that this positive state is a skill that can be trained" (Lutz et al., 2004b, p. 2).

Davidson's team conducted a similar type of fMRI research on absorption-type meditation (Brefczynski-Lewis, Lutz & Davidson, 2004). Through special goggles, subjects viewed a colored point displayed on a computer screen as a focus of attention. The subjects were divided into two groups: highly experienced meditators with over 10,000 hours of experience in meditation practice, and novices with only a week of experience. For both groups, there were increases in activity in the same areas in the visual cortex and in the fronto-parietal networks that subserve the mechanisms of attention, but the increases were much more significant in the advanced meditators.

At the present time, the findings of Davidson's group that relate specifically to rig-pa meditation and nondual awareness are not yet in print, and I am instead relying on information Davidson presented at the Mind and Life Institute's research conference in June 2004, and on my conversations with him and members of his team, Matthieu Ricard and Julie Brefczynski-Lewis. The central issue here is what characterizes the self-knowing aspect of nondual awareness. On the basis of their research so far, one could conclude that the signature of self-recognition of awareness is the appearance of large-scale fronto-parietal synchrony in the gamma spectrum.

Research of Zen Meditation

As a practicing Zen Buddhist of the Rinzai school of Zen, Austin places emphasis in his research on the insight-wisdom (Jap. kensho) aspect of meditation. Like D'Aquili and Newberg, he sees one of the principal issues regarding the neuronal processes involved in subserving meditative states to be deafferentation—a decrease in the activity of certain parts of the brain due to the blocking activity of other parts. Austin (1998) concludes that in order for insight-wisdom moments to arise in one's consciousness, major cortical areas (frontal, parietal, temporal and occipital) need to function in a different way than they usually do—that is, a number of their functions need to be blocked. "In fact, awakening will imply that *only certain parts of the whole brain are now associating,* and in a most extraordinary way. The resulting experience will be one of the brain's most striking emergent properties" (Austin, 1998, p. 259).

One intriguing question that Austin asks is: "If personal constructs in space and time drop out, how does consciousness change?" He finds that the temporal lobe, which is connected to the limbic system and involved both in emotional valence and in the "personalizing of our constructs of space and of time" (Austin, 2000, p. 211), is the main area of the brain affected by meditation. He sees the activity of the temporal lobes as being responsible for processing experience in terms of dualities such as self-other, good-bad, this-that, etc., and for attributing "conditioned emotional responses" to each pair of duality (Austin, 1998, p. 252).

In addition, he sees the superior temporal gyrus as the seat of egocentric referencing. Since meditation is associated with the relaxation of self-world constructs and the internal, usually subconscious, self-talk, and since a well-known function of the temporal lobe is of language recognition and object pattern recognition, Austin postulates that a deafferentation (decrease of activity due to the blocking action by other areas of the brain) of the temporal lobe occurs during meditation. He also examines the role of the temporal lobe in creating the subjective sense of time, and he suggests that changes in temporal lobe function affect our sense of time. He believes, based on the PET study of himself (Austin, 1998), that some aspects of self, particularly those related to referencing time in relationship to oneself as an observer, reside in the right temporal lobe. He concludes that the temporal lobes are involved in both the dissolution of self-in-space and the dissolution of self-in-time during the experience of meditation. He

equates these dissolutions with the meditative insight that reveals suchness (Sansk. *Thatata*), meaning "things as they really are."

While there is probably a large degree of deafferentation of the temporal lobes in the realization of suchness (which as mentioned, is mediated by nondual awareness), this deafferentation should not be disorientation to time and space. Rather, nondual awareness embraces all phenomena in the same way that space does.

Regarding the limbic system, because of its involvement in bottom-up and top-down processing, some degree of its de-coupling from the frontal cortex during meditation has been postulated. Austin describes the neural pathways that descend from the amygdala to the "ventromedial hypothalamus, the central gray of the brainstem and the norepinephrine-releasing cells of the locus coeruleus in the upper pons" (2000, p. 213) as being responsible for the experiences of fearfulness and guardedness. In addition, the amygdala projects strongly to the frontal lobes, thus influencing decision-making and executive control.

The decoupling of the limbic system is a contentious issue. It is natural to expect that some degree of de-coupling occurs during meditation, because one of the chief features of the meditative state of consciousness is a decrease in emotional reactivity. However, since one of the essential dimensions of nondual awareness is bliss—the open-ended emphatic nature of the potentiality for emotional experience, traditionally characterized as compassion and love, the limbic system likely plays some part in the experience of nondual awareness.

Austin also focuses on the frontal lobe's function in ordering time sequences, understanding consequences and planning the future steps of action. He then examines what happens to the sequencing of events by looking at his experience of insight-wisdom (Jap. kensho) experience. He arrives at the idea of the suspension of the past and the future as mental constructs and the suspension of habitual planning processes in relation to time. In other words, he finds the often-reported sense of eternity that accompanies the experience of nonduality.

In exploring how deafferentation of various regions in the brain occurs, Austin arrives at the centerpiece of his theory: the inhibitory function of the reticular nucleus of the thalamus. He writes:

> Every twenty-four hours, a set of normal physiological mechanisms does create a major blockade in our brains. A thin layer of cells, a mere 'cap' on the thalamus, quietly disrupts the otherwise orderly way the thalamus relays its impulses up to the cortex. These pivotal cells are the GABA neurons of the reticular nucleus. Their complex firing properties interact, in a reciprocal manner, with those of the cortex above. (Austin, 1998, pp. 267-271)

Austin points to the role of this part of the thalamus in falling asleep and in the transitions between waking, deep sleep, and dreaming, which are similar to the transitions that occur to meditators as they "traverse" different depths of meditation. He also notes that the reticular nucleus shuts down the incoming proprioceptive input to the parietal lobe, and thus relaxes one's sense of physical

self. He compares this to a state of sensory deprivation that occurs during meditative absorption (Sansk. samadhi), but then he wonders what accounts for the hyper-awareness that accompanies such sensory shutdown in meditation, and especially how the insight-wisdom experience is different from absorption in this respect. He hypothesizes a complex process of acetylcholine and glutamate stimulation, together with the inhibitory activity of the reticular nucleus and the alternating dis-inhibitory and inhibitory activity of the rostral nuclei of the dorsal thalamus (Austin, 1998).

In his theorizing Austin remains focused on the sub-cortical structures, mainly the thalamus. What remains to be seen is whether the thalamus is the switch that allows for the changes from ordinary states of consciousness to those of pure consciousness and of nondual awareness, and thus accounts for the large-scale synchronies mentioned earlier.

Austin also attempted to research an awareness-type meditation by conducting a PET scan of himself citation here. With his eyes and ears plugged, he concentrated on abdominal breathing, was alert and aware, but otherwise was not involved in any cognitive task. He reported activations the subcortical regions of the basal ganglia nuclei, the caudate and putamen, and in the thalamus. In the cortex, he reported activity in the middle, inferior, triangular, and opercular regions of the frontal lobes, the transverse and superior temporal gyrus, the precuneus, and the cuneus (Austin, 1998).

A significant finding in this study is the higher activity on the right side of the cortex, especially in the regions of the parietal and occipital lobes. Austin

attributes the relative decrease of activity on the left side of the cortex to the nonverbal nature of the experience. In contrast to this, the PET scans of the control group—subjects who were resting but not meditating—showed increased activity on the left side of the cortex, particularly in the left temporal region associated with language processing, indicating that while resting, subjects are subconsciously involved in internal talk.

The question is, however, was Austin's awareness self-recognized or not? The self-knowing nondual awareness differs from the ordinary resting meditative awareness in that the awareness rests in its own nature—that is, the awareness knows itself directly. In other words, the awareness is self-recognized or realized. This distinction shows as a difference in brain functioning, most notably as the fronto-parietal synchrony.

One of Austin's key concepts in understanding brain functioning during meditation is the difference between neural correlates of allocentric and egocentric spatial reference. In commenting on the perceived dissolution of the habitual sense of self in meditative awareness, he states: "My old personal limbic valences seemed to have dropped off. No longer could they polarize either side of such opposites as: self/other, now/then. Once all such covert dualities implicit in 'self' disappear, which residual functions could now lend structure to the field of awareness? Allocentric functions" (Austin, 2000, p. 228).

Somewhat surprisingly, Austin does not focus on the functions of the parietal cortex in subserving the egocentric-allocentric orientation. Instead, he

observes that the cells of the internal medullary lamina of the thalamus and the posterior hippocampus appear to operate like a global positioning system (GPS) "and are sensitive to one particular point inside the *absolute* field of space" (Austin, 1998, p. 491). This is in contrast to egocentric cells which reference in relation to oneself. Austin quotes research on the increased metabolic activity in the anterior cingulated gyrus and right pre-frontal cortex during global outward-turned attention, and he concludes that during moments of insight-wisdom, one's egocentric references cease and instead, "a fully conscious witness occupies center stage, a nonentity who still sees, all around, the wide-open spectacle of circumspace…" (Austin, 1998, p. 492).

Realizing nondual awareness precipitates a shift in attention from exclusive preoccupation with oneself to a more global awareness of one's surroundings and one's situated-ness. However, it is an oversimplification to see this as a forced choice between an egocentric and allocentric frame of reference. It is possible that these types of conclusions are motivated by the generally held belief that meditation practice leads to focusing on others and disregarding oneself. This indicates a dualistic split, for surely a co-dependent person who is solely focused on others is not enlightened, even though his or her behavior might seem, to an untrained eye, to resemble the enlightened spirit of giving.

As pointed out in other research (Blackstone, 1997), from a phenomenological perspective, nondual awareness pervades equally throughout space both inside and outside oneself. In this way, one has full access to the depths of one's authentic being. This means that in nondual awareness, one is

never a "nonentity." Austin does state that the removal of the "I-Me-Mine" mental structure leads to the "i-me-mine" consciousness, which he calls "a more genuine self" (Austin, 2000, p. 210). He also hastens to point out that enlightenment is not a state of depersonalization. However, misconceptions of this type appear to be a significant problem in Asian contemplative traditions, due to the general cultural bias toward self-abnegation (Almaas, 1986).

Neuroscience Summary

To summarize, current research indicates that neural substrates of pure consciousness without experience, are characterized by deafferentation of a number of areas in the brain due to the activity of the dorso-lateral pre-frontal cortex, such as those in the parietal and temporal lobes, which is then sustained through reverberating re-entrant loops connecting the active areas of the cortex in the pre-frontal lobes with the thalamus and basal ganglia. While the research of nondual awareness, pure consciousness with experience, has yet to be published, the neural correlates of nondual awareness most likely involve large-scale fronto-parietal synchrony.

The existing research and hypotheses are in many ways extraordinarily important, as they pave the way toward the larger goal of understanding the neural correlates of consciousness. What has been missing in the literature is a deeper analysis of the neural correlates of space as they relate to nondual awareness. This is not the space as a conceptual experience, nor the allocentric spatial perspective as opposed to the egocentric one. Rather, it is the neural correlate of the sameness

of space inside and outside, the space of nondual awareness, that needs to be found.

CHAPTER THREE: REVIEW OF LITERATURE B—ASIAN PHILOSOPHY

In the previous chapter the question that emerged was: what are the neural correlates of nondual awareness? In order to explore this question further and make it more precise, this section of the literature review will examine what nondual awareness is, and how nondual awareness is related to the experience of space. This topic has only been explored in Asian nondual philosophies: Advaita Vedanta of Hinduism, and Dzogchen and Mahamudra of Tibetan Buddhism. The present study will rely on three sources of texts: translations of the original source texts, contemporary academic scholarship, and the practitioner-teachers of these traditions.

A question that arises immediately in attempting a review of literature in Asian philosophy is: what constitutes academic scholarship in the field of Asian philosophy? As Wallace (2003) has eloquently argued, there is considerable cultural chauvinism in Western academia, which assumes that since Asian philosophy is not based on the same foundation and does not follow the same rules as Western philosophy, it is not really a philosophy. Furthermore, while there is a tendency to disregard writings of the authentic philosopher-practitioners within these traditions, Western scholars who consider themselves "orientalists" often make their conclusions solely on the basis of applying Western principles of text analysis to the source materials, without having proper introduction to the tradition they are studying, and without any experience in meditation. This has lead to numerous misunderstandings of the subject. For example, Wallace quotes Griffiths, who defines meditation as: "some kind of profound cataleptic trance,

the kind of condition manifested by some psychotic patients and by long-term coma patients"(p.9). Such grossly misguided statements offered from a position of academic authority have contributed to the disregard for Asian philosophy commonly found in Western academia. A more fundamental issue, Wallace (2003) writes, is that most Western scholars are incapable of imagining that Asian contemplative traditions have discovered valid ways of knowing that are unknown in the West. Therefore, the most authoritative sources for the study of Asian philosophy are the practitioners who are also scholars in their traditions. (The title "Khenpo" or "Geshe" in Tibetan Buddhism is the equivalent of Ph.D.)

Before proceeding further, a few other significant issues need to be mentioned because they arise repeatedly in studies of Asian philosophies.

First, in order to examine the traditional notions of nondual awareness, it is necessary to clarify the intended meaning of a text. As the Dalai Lama points out (Zajonc, 2004), there are three possible levels at which a traditional text on meditation can be understood: a) as a metaphysical and ontological statement about reality, referred to in Tibetan Buddhism as the "Ground"; b) as a skillful means or a description of a method of practice, referred to as the "Path"; and, c) as a description of the meditative experience of nonduality, a phenomenological statement about the experience from the level of nondual awareness, referred to as the "Fruition."

In the early Upanishads, on which Advaita Vedanta is chiefly based, the most commonly found statements are descriptions of spiritual experiences of

oneness in the form of ecstatic proclamations. Along with these, we find very early evidence of cosmological and metaphysical thinking—demonstrating attempts to understand the world and life on the basis of the experience. Here, I think, we find the original conflation that plagues all Asian nondual philosophies, which is also the conflation that points to a core issue of human spiritual and religious endeavor: To what extent can spiritual experience, and the insight gained from it, be used as evidence for what the Universe is and how it works, and as a guide to conduct human life on this planet, both individual and communal?

Buddhist tradition, in general, while much more careful to distinguish between the three mentioned levels of meaning, also suffers from lack of clarity in this way. The most frequent examples of this are found in later developments of Indian Tantric Buddhism, from the eighth century A.D. on, as the ecstatic poem became the favorite mode of expressing one's spiritual insight – as shown in the works of Saraha and Tilopa among others, and in Dzog-chen tradition in the works of Longchen Rabjam, known as Longchepa.

The second important issue is the question of what constitutes a valid means of knowing. As mentioned in the introduction, the epistemology of nondual awareness is outside the scope of this dissertation. However, in order to better appreciate statements found in the classical sources, this issue needs to be briefly addressed. Mystical traditions ultimately regard direct experience or realization to be the only valid way of knowing. In his introduction to the Astavakra Samhita (Nityaswarupananda, 1981), Mookerjee states that Vedanta

philosophy admits a three-fold criterion of truth: scripture, logic and self-realization, and that the scripture is valid only because it is a testament of the experiential realization of the 'seers of Truth', and open to attestation by the newcoming seers.

Third, any study that attempts to present the Buddhist and Hindu traditions side by side risks running afoul of both. The roots of the schism between the two appear to be rooted in a rather trivial ethnic divisions: Hindu tradition purportedly comes from Brahmanas living long ago in the western parts of the Indian subcontinent in today's Pakistan and Rajastan, while Buddhism, like Jainism, originated later among Shramanas living in the northeastern part of India and in today's Nepal. One view sees Buddhism as an outgrowth of Hinduism, a heterodox school of Hindu philosophy (Radhakrishnan, 1995), which essentially expresses the original insight of the early Upanishads. The other sees Buddhism as originating from a different root – unrelated and fundamentally opposed to the Hindu tradition. As explored later in this chapter, the basis of this argument is a disagreement over whether ultimately there is a real ground underlying the impermanent flux of experience, or whether reality is essentially groundless and empty.

Fourth is an ongoing issue of translation. The Sanskrit and the Buddhist Tibetan languages are predominantly poetic and rely extensively on metaphors and hyperboles. Translating them to the cut and dry practical Western languages of modern times, has led to widespread mistakes of taking the various

pronouncements too literally. Furthermore, because the nature of meditative experience is essentially trans-rational and does not fit neatly into the linear structure of language, the meaning of various terms is often stretched to accommodate a variety of meanings. Thus, it is challenging for translators to discern the intended meanings, especially if they have not arrived at the experience of the topic in their own meditation practice. For example, the Sanskrit language word *Atman*, which means self, is usually translated as "Self" with a capital "S" to denote one's true ultimate self-identity as pure consciousness. However, in the West, it is often mistranslated as the "soul," which technically has a different meaning in Vedanta: In addition to meaning one's pure consciousness, the soul also includes one's basic ignorance and the energy-memory that makes one a unique individual. The word *akasha*, which is Sanskrit for "space," is also often mistranslated as "ether," a non-existent subtle substance from nineteenth century physics, which then obscures the intended meaning. Many more such examples exist.

A more complicated problem arises when one needs to use the word *experience* in a sentence that refers to the phenomenological level of pure consciousness and-or nondual awareness. Summarily then, one could reject the statement as not representing the true realization of nonduality because, strictly speaking, there can be no experience, as the tripartite structure of experiencer-experience-experienced is transcended. Furthermore, neither pure consciousness nor nondual awareness can be objects of experience as they are the essence of subjectivity. In that sense the objections to using the word *experience* are valid;

nevertheless, in the present work, the term *experience* will be used liberally, to facilitate sentence construction and to denote the phenomenological level of nondual awareness.

The term *consciousness* is another example of this type of a problem. Hindu texts use the term *consciousness* (Sansk. vijnana or prajnana) to denote both the consciousness in general and, specifically, the pure consciousness or nondual awareness. In Buddhism, on the other hand, the term consciousness refers only to instances of dualistic cognitive processes, which divide experience into subject and object, and never to pure consciousness and nondual awareness.

Finally, the fifth issue is the exasperating issue of dating the texts and sources. The dating of ancient Indian sources is notoriously imprecise, due to the cultural disregard for keeping track of time. In addition, accurate dating is made more difficult by the bias of the nineteenth century European translators for establishing the superiority of Western culture by altering the dating of Indian source texts (Klostermaier, 1994). It is likely that the roots of Vedanta and Yoga are much older than these translators decided, possibly as old as 4000 B.C.E. (Fuerstein et al, 2001). Undoubtedly, Vedanta and Yoga have been developing together in an ongoing dialogue since pre-Buddhist times, a polemic made only richer and more precise, with the arrival of Buddhism and Jainism. Buddhists are a bit more precise with respect to dating, but still there are numerous uncertainties, such as the fact that the different sects place the Buddha's birth more than a hundred years apart (Klostermaier, 1994). The hagiographical

accounts muddle the issue further. For example, all of the Buddhist Tantric teachings are attributed to Buddha Shakyamuni (563-483 B.C.E.), while historically, Tantra emerged no earlier than the fourth century C.E. (Wayman, 1999).

Pure Consciousness

In order to understand what nondual awareness, the subject of my research, is in the traditions of Advaita Vedanta, Dzogchen and Mahamudra, and in particular the relationship of nondual awareness and space, the first topic that needs to be examined is what is pure consciousness.

General Definition and Derivation

The discovery of pure consciousness, and of its relationship to the nature of experience, is arguably the greatest contribution of the Indian culture to the human quest to understand ourselves and what it is to be conscious. It is also the very foundation upon which most of the nondual philosophies of India and Tibet rest. Pure consciousness is consciousness in itself, different from the various states of consciousness such as waking, dreaming and altered states, and different from the functions and contents of consciousness. It has been described traditionally as the empty cognizance devoid of content (Dalai Lama, 1985) or, as a unity of lucidity and emptiness (Trangu, 2005). Forman (1996) defines it as: "a wakeful but contentless (non-intentional) consciousness" (p.185). It is consciousness prior to the arising of experience.

From the perspective of our ordinary daily consciousness, it is rather extraordinary that we can experience consciousness without anything to be conscious of. This is a challenging idea for most Western scholars. Steven Rose expresses a commonly found scientific assumption: "There can be no consciousness without content; indeed it is constituted by its content…" (Rose, 2005). To make things more complicated, it cannot even be said that one experiences pure consciousness, because there is no separate subject doing the experiencing in this state, nor can pure consciousness be an object of knowing (Forman, 1998). Rather, according to these nondual philosophies, pure consciousness is the innermost essence of our subjectivity, of who we are, the us who is conscious.

History does not know with certainty how the ancient Indians were first able to isolate consciousness from the flux of experiencing. Hindu legends tell of "seers" receiving the knowledge directly from the source—the cosmic consciousness (Venkatesananda, 1984). Buddhist legends describe a succession of Buddhas preceding the historical Siddhartha Gautama (Kongtrul, 1995). Available evidence suggests that this realization had occurred quite early on, in the Vedic period (c. 2700-1200 B.C.E.) (Klostermaier, 1994), and possibly even earlier in the Harrapa and Mohenjo Daro civilizations (Feuerstein, Kak & Frawley, 2001). The ancient seers, in their quest to find the foundation of existence, arrived at that which they thought both phenomenologically and ontologically preceded the worlds of gods, humans and other creatures (Deutsch, 1973).

Based on the reports of practices among Siberian shamans (Eliade, 1964), it is likely that the methods leading to the experience of pure consciousness arose among Neolithic peoples as a continuation of the shamanic journeys they took in dreams, trances and other altered states of consciousness. Over the strenuous objections of Indian scholars, some also suggest that the insights of Vedic tradition occurred due to the ingestion of mind-altering plants (Smith, 2000). Others suggest that the experience of pure consciousness can occur spontaneously, as when one attains lucidity during deep sleep (Wilber, 2000b). At such times, there are no noticeable experiences of any kind, not even a sense of time or space. All is black but the awareness is present, as if blackness were lit from within itself. It is one's own awareness; there is no one and nothing else there. One is conscious and knowing that he or she is conscious, yet having no thoughts.

In order to arrive at pure consciousness, traditional meditation techniques utilize either the concentration-absorption method, which mimics the awake-in-deep-sleep state (Saraswathi, 1989) or the negation of misidentifications through conceptual analysis (Gangolli, 1991). Both methods lead to the progressive quieting of mental functions, until all that is left is pure consciousness or awareness itself. Understandably, arguments about the superiority of one approach over the other, and the position of each method within specific traditions, have been ongoing for centuries (Comans, 1993). These techniques and arguments are outside the scope of this dissertation. Regardless of the method employed, the central feature is the turning around of one's attention, so to speak,

so that instead of being focused on the content of one's experience, the awareness is focused on itself (Shear & Jevning, 1999). In this sense, meditation is the practice of directly experiencing the nature of consciousness. It is the direct experiential method by which consciousness comes to know itself (Josipovic, 1998).

Pure Consciousness in Advaita Vedanta

In Advaita Vedanta, pure consciousness has been traditionally described by its three primary characteristics as the inseparable *sat-cit-ananda* or being-awareness-bliss, also translated as truth-knowledge-bliss, or sometimes as being-awareness-bliss-self. These indicate the nature of one's experience of pure consciousness: it exists; it is conscious; it is blissful; and it is one's own innermost self. Klostermaier re-states the Vedantic definition of the pure consciousness as: "*Atman* is pure consciousness that remains even after *manas*, rational thought, has passed away. *Atman* is ultimately *sat-cit-ananda*" (1994, p. 415).

The early Upanishads use two terms for pure consciousness: *Atman*, which means the Self when seen from the viewpoint of the individual (the capital "S" indicating the ontologically deepest level of self-identity); and *Brahman*, meaning the pure consciousness seen from the universal perspective. (*Brahman* is a different term than both *Brahma*, meaning God the creator, and *Brahmin,* a member of the Brahmin caste).

> Brahman is conceived as an impersonal cosmic principle. If, however, this cosmic principle is a being whose very nature is bliss, then it must be

> a conscious being, since, whatever else it may be, bliss is a conscious state. So we may define Brahman as a being whose very nature is a blissful state (Brooks, 1968, p.8).

The identity of Atman and Brahman, of individual and universal pure consciousness, is one of the central themes of Advaita Vedanta. The metaphysical implications of this idea, and the question of reification are not the topic of this dissertation. Rather, it is seen here as a description of the experience of pure consciousness, in which the apparent boundary between the pure consciousness within oneself and the pure consciousness outside of oneself is dissolved.

Hamilton (2001) describes the union of Atman and Brahman as the union of inner self and cosmos. In this she interprets these concepts very generally. The classical Advaita Vedanta position is much narrower and precise, as evidenced by the Vedantasara of Sadanananda Yogindra (Nikhilananda, 1949). In it, Atman, which is pure consciousness only, is identical to Brahman, which is the universal pure consciousness. As the famous simile describes, the two are one, just as the space inside a pot is continuous and identical to the space outside of the pot. Deutsch (1973) agrees with this position when he discusses the famous mahavakya or great saying "That thou art." (Sansk. Tat Tvam Asi), which occurs in the Chandogya Upanishad: "That which is the subtle essence this whole world has for its self. That is the true. That is the self. That art thou, Svetaketu" (Radhakrishnan, 1995, p. 465).

In another example of addressing this issue Isayeva identifies Atman-Brahman simply as Being (1995). The strength of this approach is that it encompasses different levels of reality and different interpretations. Unfortunately, in doing so, it loses the precision and essence that other meanings have. Elsewhere, however, Isayeva retains the identification of Atman with pure consciousness (1993). There is confusion about these descriptions present in the early Upanishads themselves. There are continuous, apparently contradictory statements such as "*neti, neti*" (Sansk. not this, not this) which indicate that Atman-Brahman is that which is left after everything else has been negated. At the same time, and in the same Upanishad (the Chandogya), there is the statement "All this is Brahman" – proclaiming the unity of all things in existence. As Hamilton (2001) correctly points out, these and other inconsistencies are partly due to the fact that the early Upanishads represent compilations of chanted verses gathered and passed down through oral tradition for hundreds, if not thousands, of years.

More importantly, as elaborated later in this study, these discrepancies indicate two different aspects of meditative consciousness: pure consciousness and nondual awareness. Furthermore, on the absolute level, there is a nonduality of individual pure consciousness with the pure consciousness that appears to pervade the Universe. On the relative level, there is an interconnectedness and interdependence of all things in existence.

Pure consciousness as witness. Radakrishnan traces the earliest record of the concept of pure consciousness to the Atharva Veda where "the Supreme in a

form of Varuna [an early Vedic god] is described as the universal omnipresent witness" (1995, p. 45). This function of pure consciousness being the silent uninvolved witness is repeatedly stressed and developed in the Upanishads and in all later Vedanta. For example, in the Astavakra Samhita is the following verse: "The Self is witness, all-pervading, perfect, One, free, Consciousness, action-less, unattached, desire-less, and quiet. Through illusion It appears as if It is of the world" (Nityaswarupananda, 1981, p. 11).

The Kaivalya Upanishad describes pure consciousness as a witness in its characteristic style of self-proclamation: "I am the Witness, the Pure Consciousness, the Ever Blessed, different from what constitutes the enjoyer, enjoyment and the object of enjoyment, which one experiences in the three states" [the three states being waking, dreaming and deep sleep] (Nikhilananda, 1949, p. 37).

This witnessing indicates that pure consciousness can also function during other states of consciousness, such as waking and dreaming, rather than only when completely isolated from any experience, as the term "pure" might imply. Contemporary transpersonal psychologist Ken Wilber writes:

> And so, as you rest in the pure Witness, you won't see anything in particular—whatever you see is fine. Rather, as you rest in the radical subject or Witness, as you stop identifying with objects, you will simply begin to notice a sense of vast Freedom. This Freedom is not something you will see; it is something you are. When you are the Witness of thoughts, you are not bound by thoughts. When you are the Witness of

feelings, you are not bound by feelings. In place of your contracted self, there is simply a vast sense of Openness and Release. As an object, you are bound; as the Witness, you are Free. (Wilber, 1997, p. 189)

Pure Consciousness in the Tibetan Buddhist Tradition

According to both the old and new translation schools of Tibetan Buddhism (the Dzogchen Tantras, and the Guhyasamaja, Chakrasamvara and Kalachakra Tantras), pure consciousness (or clear light awareness) arises naturally, if briefly, during the process of dying, after all mental functions have become extinguished (Dalai Lama, 2003). On the basis of this, some postulate that the physical body and the brain are cooperative (contributing) causes of mental functions while the clear light awareness is the substantive cause – the connection between them and the meditating of memory being carried by the energy of primordial elements (Dalai Lama, 1996).

The new translation school tantras – the Guhyasamaja and Kalachakra Tantras in particular – distinguish between several different levels of clear light (Cozort, 1986). The initial distinction is between the subjective and the objective clear light, the former relating to pure consciousness subjectively realized and the latter to the emptiness (Sansk. *shunyata*) that is the nature of phenomena in general.

Discussing the clear light (pure consciousness) in the context of the Kalachakra Tantra, where it is called *yeshe* or primordial wisdom, Kirti Tsenshab Rinpoche says that it combines very subtle energy (*wind*) and very subtle

consciousness (mind) "mounted on this wind. This combination is energy and consciousness in their most refined form. The inner yeshe is that combination of wind and mind dwelling within the individual; the outer yeshe is the mind-wind combination that pervades all of existence" (2004, p. 21).

This idea is particularly interesting because it directly contradicts other Buddhist teachings according to which there is no universal pure consciousness, but rather the Buddha nature or the innate clear light is limited to each individual (Dalai Lama, 1997b). Here the Kalachakra Tantra appears to express an insight similar to that of the pre-Buddhist Upanishads: the identity of individual and universal pure consciousness.

Based on the subtlety of the pure consciousness experienced during meditation practice, the clear light is classified as either coarse, metaphoric or, actual (Cozort, 1986). Coarse clear light is the ordinary consciousness that realizes emptiness; metaphoric clear light is a special blissful consciousness occurring as the result of withdrawing one's vital energy into the central channel and therefore realizing emptiness very vividly; and actual clear light is the innate pure consciousness itself, independent of body and mind.

Dzogchen tradition, or the old translation school, distinguishes between two types of clear light: clear light at the absolute level, which is termed "natural pristine awareness" which arises only during death; and clear light at the relative level, which is termed "effulgent pristine awareness, or pristine awareness involving the appearance of the basis" (Dalai Lama, 1996, p. 170) which arises simultaneously with various states and functions of consciousness. This second

category is in the present study termed "nondual awareness" – and is discussed in more detail later in this review.

As noted previously, pure consciousness occurs not only in death, but also during meditative absorption and in deep sleep lucidity. However, one could argue that the innate natural pure consciousness fully manifests only during the process of dying, when it completely separates from the body.

Within the Tibetan Buddhist traditions of Dzogchen and Mahamudra are characterizations of pure consciousness (clear light or natural pristine awareness) that parallel those in Advaita Vedanta. Natural pristine awareness has two aspects: an empty space-like aspect and a luminous clear light aspect, which is its cognitive property (Gyamtso, 2004). It is also referred to as emptiness, luminosity and bliss.

Pure Consciousness Summary

Pure consciousness, as understood in the Hindu tradition of Advaita Vedanta and in the Tibetan Buddhist traditions of Mahamudra and Dzogchen, is an open-ended cognizance empty of content, or consciousness-in-itself. It is termed *pure consciousness* in Advaita Vedanta; *pure* indicating that it is without any experiences. In Tibetan Buddhism it is termed the *clear light*. Pure consciousness is self-knowing; that is, it knows itself directly, without reliance on thoughts or imagination. This understanding of pure consciousness is in agreement with the majority of sources in Advaita Vedanta and Tibetan Buddhism. It contradicts the positions of a number of Mahayana and Teravada schools of Buddhism, which see consciousness only as momentary dualistic

subject-object cognition. Also, it contradicts those views in Western philosophy and cognitive psychology which see consciousness as being a construct and as propositional in nature (Katz, 1978; Phylyshyn, 2002).

Pure consciousness as seen by the above-mentioned traditions of Asian philosophy, is the nature of consciousness, in contrast to the various states, functions and contents of consciousness, which are seen as its transformations. Because of this, it is especially significant to neuroscience's overall goal of finding the neural correlate of consciousness.

Nondual Awareness

Both sources within Tibetan Buddhism and Advaita Vedanta support the idea that pure consciousness can function with, and as a context of, all experiencing. When pure consciousness functions with daily experience, it is termed *nondual awareness* (to distinguish it from ordinary dualistic awareness), and it has the following characteristics: It is a non-fragmenting of the field of experience into subject and object, which is experienced as sameness of space inside and outside oneself (Rabjam, 2001a). It is self-recognized, it knows itself, and as such it is a self-knowing awareness (Rangdrol, 1990). It is the inherently present, but obscured, potential and essence of every conscious being (Rangdrol, 1990). Its main characteristics are emptiness, luminosity and bliss, in other words it is inseparable being-awareness-bliss.

Tibetan Buddhist texts use a number of different terms to indicate non-dual awareness (Tib. *rigpa*): pure awareness, timeless awareness, pristine

awareness, self-knowing awareness, pure presence, clear light awareness, etc. While these all refer to the same nondual awareness, they contain slight differences in emphasis of its various aspects. It is important to note that Advaita Vedanta texts use the same terms for nondual awareness as they do for pure consciousness: Atman or Self, and Brahman. As seen later, this has led to some confusion in interpretation.

Nondual Awareness in Tibetan Buddhism

Arguably, the most developed teachings of nondual awareness are within the Dzogchen tradition of Tibetan Buddhism. This tradition traces back to the legendary Indian teachers Prahevajra (Tib. Garab Dorje), Manjusrimitra, and Sri Singha. Most likely, these teachers lived sometime in the seventh to ninth century C.E., although traditional accounts give a variety of dates, as far back as the first century B.C.E. Their teachings are not available in original form, but only through more recent Tibetan translations and commentaries (Norbu, 1987; Norbu & Lipman, 1986). Scholars think that these teachers and the translator Vairocana established the three major lines of Dzogchen teachings: a) Semde, or the mind series, which emphasizes intellectual understanding of the correct view; Longde, or the space series, which emphasizes seeing all phenomena as manifestations of nondual awareness; and c) Mengagde, or the secret oral transmission, which emphasizes direct introduction and ongoing abiding in self-knowing nondual awareness (Rabjam, 2002; Reynolds, 1989).

Most Dzogchen teachers and followers regard the Mengagde as being superior to the other two approaches, in that it is a more potent and complete way of introducing one to nondual awareness. It consists of two sections of teachings: a) Trekcho, or "cutting through the solidity," which has to do with the primordial purity (Tib. *ka-dag*) of nondual awareness; and b) Todgal, or "leaping over," which has to do with the spontaneous presence in which all phenomena are realized to be the radiance of nondual awareness (Rabjam, 2002).

Even though Dzogchen teachings regard ultimate reality as being ineffable (Rabjam, 1998), they directly contradict the Mahayana teachings on the absence of any type of ground of reality. In Dzogchen the ground of being, termed the Base (Tib. *gzhi*), is regarded as absolutely positive. It is understood as having two aspects: its essence, "the luminous space of great emptiness inseparable from innate wakefulness" (Rangdrol, 1990, p. 5); and its nature (Tib. *rang-bzhin*), the radiance of innate wisdom manifesting as the appearance of inner light. These essence and nature aspects of the ground of being are also known in Dzogchen as the primordial purity and spontaneous presence, respectively, and their union is the energy of compassion (Rangdrol, 1990).

Dzogchen tradition emphasizes that pure consciousness or clear light can be present with different states and functions of consciousness. Thus, "Any given state of consciousness is permeated by the clear light of rigpa's pure awareness" (Dalai Lama, 2004, p. 48). Interestingly, there are statements in some Mahayana sutras indicating the presence of pure consciousness with perceptions and other experiences, like this statement from the Surangama sutra: "Your body and mind

as well as external mountains, rivers, space and the great earth are but phenomena within the wondrous bright True Mind" (Yu, 1971, p. 59).

There has been an ongoing argument, both within Buddhism itself and between Buddhism and Hinduism, as to whether these kinds of statements indicate not just a phenomenological truth but also an ontological one. In the above quote, the question is whether the "True Mind" is the same concept as that of Brahman in Hinduism, which is sometimes conceived of as the pure consciousness encompassing all creation. As mentioned previously, the Dalai Lama (1997b) claims that this is not the case, as there is no universal all-encompassing consciousness, while others, even some within his sect (Geleg, 2004; Tsenshab, 2004) regard such statements as ontological truths.

In the Dzogchen tradition, there are frequent statements implying ontological and metaphysical ideas. Longchen Rabjam (1308-1363 C.E.), commonly known as Lonchepa, who is the central figure of the Dzogchen tradition and its most prolific expounder, describes the experience of nondual awareness in a way that can be interpreted both as a phenomenological and as an ontological statement: "Everything is subsumed within all-inclusive awakened mind. Since there is no phenomenon that is not included in awakened mind, the nature of all phenomena is that of awakened mind" (2001b, p. 53). Furthermore, he makes a clearly metaphysical statement, similar to those found in Hinduism, in which he ascribes the origination of the world and human experience to the failure to realize nondual awareness, and the subsequent fragmentation into dualistic subject and object apprehending (Rabjam, 2002).

Dzogchen tradition recognizes three types of nondual awareness or rigpa, which here it calls pristine awareness. The Dalai Lama, connecting the idea of nondual awareness to pure consciousness or clear light, explains these types as follows:

> *Basic pristine awareness* (Tib. *gzhi'i rig pa*) acts as the basis of all samsara and Nirvana, and is identical to the subtle clear light. This is the pristine awareness one experiences at the time of death, but not during ordinary waking state. It is from this awareness that the foundation consciousness (Sansk. *alaya vijnana*) arises. Then, through meditative practice, after the experience of foundation consciousness you can experience a second kind of pristine awareness, namely *effulgent awareness* (Tib. *rtsal gyi rig pa*). The third kind of pristine awareness is called *natural pristine awareness* (Tib. *rang bzhin gyi rig pa*). Where does this natural awareness come in? As a result of meditative practice it is possible to gain direct experience of subtle clear light, and the subtle clear light so experienced is said to be the natural clear light, as distinguished from the basic clear light. The basic clear light is experienced only at the time of death. (Dalai Lama, 1997, p. 122)

Within Dzogchen there also exists a division of nondual awareness into the essential and the effulgent rigpa, where the essential rigpa is that nondual awareness which occurs naturally as the background of all conscious states, and the effulgent rigpa is the nondual awareness occurring in the presence of various

experiences. Dodrupchen Jikme Tenpe Nyima (Dalai Lama, 2004) outlines four possible states of the essential and effulgent rigpa. First, the *essential rigpa without effulgent rigpa* is nondual awareness that is simultaneously present whenever there is clear and aware consciousness. It is an indwelling clear light, also known as the "rigpa of the ground." Second, the *effulgent rigpa without essential rigpa* is nondual awareness that arises when various functions of the mind are active. It is also known as "rigpa as energy" or "rigpa of the appearance of the ground." Third, the *rigpa that is both* is the case of effulgent and essential rigpa arising simultaneously. It occurs in advanced stages of meditation practice. Fourth, the *neither effulgent nor essential rigpa* is the consummation of meditation practice according to Dzogchen. It is also known as the "rigpa of all-embracing spontaneous presence which is the ultimate state of freedom"(Dalai Lama, 2004, p.184).

These differentiations of rigpa or nondual awareness can be seen as pertaining to the absolute and relative aspects of nonduality. That is, the essential rigpa is space-like awareness, while the effulgent rigpa is awareness related to the energy or dynamic aspect of manifestation. One could see the other types of rigpa as stages of integration of the absolute and the relative. That is, the *rigpa that is both* is the realization of the simultaneous presence of the absolute and relative aspects, while the *rigpa that is neither* is the realization of their complete union in which any trace of difference between them has disappeared.

This understanding of the progression through the stages of union of the absolute and relative occurs also in Zen in the teaching on the Five Ranks of

Tozan (Yu, 1971) and, in its more mystical and metaphysical rendition, in Vedanta (Radhakrishnan, 1995).

Nondual awareness as space in Tibetan Buddhism. When pure consciousness or clear light is self-recognized within daily experience as nondual awareness, one realizes it to be space-like, in that it relates to phenomena in the same way that space as context is related to various objects that are its contents.

Numerous statements in Dzogchen and Mahamudra texts compare nondual awareness to space (Gyatrul & Wallace, 2000), and some go even further, to point at their phenomenological identity (Lingpa, 2001). As seen in the following three passages, Longchepa, in particular, emphasizes the similarity of space and nondual awareness (translated by Richard Baron as *timeless awareness*): a) "Original basic space is described as Buddha Nature—buddhahood that is spontaneously present by nature. ...Thus, awareness—naturally occurring timeless awareness—is the basic space of phenomena" (Rabjam, 2001b, pp. 5-6); b) "The completely pure expanse in which objects never exist is the expanse of awakened mind, the supremely blissful ground equal to space" (Rabjam, 2001b, p. 352.); and c) "Even the enlightenment of all victorious ones of the three times is spontaneously present as a supremely blissful state of natural rest. So, without depending on the teachings of causality that are for less fortunate ones, look to the nature that is like space, in which nothing need be done" (Rabjam, 1998, p. 39).

Nondual Awareness in Advaita Vedanta

The status of nondual awareness in Advaita Vedanta is somewhat uncertain due to several factors such as: the multiplicity of world views presented in the early Upanishads; the continual shifting of presentation between phenomenological, epistemological and metaphysical levels (Deutsch, 1973); the extreme brevity of some key texts such as the Brahma Sutras which allow for a number of different interpretations, and; the ubiquitous questioning of the value of the external world that is endemic to the Hindu tradition as a whole.

Advaita Vedanta, like Sankhya-Yoga, represents the satkaryavada theory of reality, according to which an effect is pre-existent in a cause. In contrast to this, Buddhism represents asatkaryavada theory, according to which an effect is not pre-existent in a cause. While a thorough discussion of the logic of these theories is outside the scope of this dissertation, it could be summarized in the following way. Satkaryavada claims that the world and our experiences pre-exist as a potential in pure consciousness out of which they arise. Asatkaryavada, on the other hand, claims that the world and our experiences are not created by the clear light nor by any other type of first cause—but rather that they dependently originate based on previous moments of their existence. Compared to the Buddhist idea of dependent origination, the Vedantic theory of causation (satkaryavada) is not about phenomena causing each other in an endless chain—many from many—but rather about the multiplicity arising from one source only—the absolute pure consciousness (Potter, 2002).

The satkaryavada doctrine has two branches: vivartavada, also known as mayavada for Shankara's theory of maya, and parinamavada. Vivartavada holds that the phenomenal world is merely an illusory appearance (Sansk. *maya*) and that only pure consciousness as Brahman is real. Parinamavada, on the other hand, regards phenomenal reality as a true transformation of pure consciousness (Deutsch, 1973). While some hold that Advaita Vedanta represents only the vivartavada viewpoint and that parinamavada is essentially the doctrine of Sankya-Yoga, there are interpretations of Advaita (contemporary teachers in particular) that expound the parinamavada viewpoint (Gupta, 1978).

The relevance of these two branches to understanding nondual awareness is that they differ on the central issue – whether nondual awareness is possible at all. Vivartavada's claim that phenomena are illusory appearances due to the projecting of names and forms onto pure consciousness, akin to the way one can look at a rope coiled on the ground and perceive it to be a snake (especially in India) implies that when one realizes pure consciousness, there can't be any experiences at all. This interpretation is usually ascribed to Shankara (Klostermaier, 1994), but more properly it originates with his predecessor Gaudapada (c. 600 A.D.). Shankara argued that this is the central meaning of the Upanishads, especially the oldest ones, Brihadaranyaka and Chandogya (Radhakrishnan, 1995). Today, Advaita Vedanta teachers such as Gangolli (1991) continue to subscribe to this. They not only hold that pure consciousness alone is real, but also that no meditation practice is needed at all to realize it; rather, it is enough to understand the truth from reading the texts, especially the mahavakyas

or the great sayings such as "I am Brahman." In this they bring out Shankara's own view of the importance of *sruti* or the revealed texts. Yet, as Deutsch (1973) stresses, Shankara never considered dispensing with meditation practice altogether, only warning against getting stuck in various states of absorption.

Gaudapada was Shankara's grand-guru and the author of the famed Karika to Mandukya Upanishad, which is still regarded by some as the purest expression of Advaita Vedanta. His philosophical approach is known as *asparsha* or non-contact, as he held that there is no true contact between pure consciousness and experience. This theory is also known as *ajativada* or non-origination. It states that the phenomenal world is a mere illusion, and that absolute pure consciousness cannot become the relative world of phenomena, just like the rope does not truly become a snake. The external world of sense perceptions and the internal world of one's experiences are both unreal; change is an illusion, and only pure consciousness exists (Gambhirananda, 1990). There are clear echoes of Nagarjuna here, but Gaudapada takes the negative logic much further. He asserts that not only are phenomena empty of self-existence and beyond the four extremes of existence, non-existence, neither, and both, because they are dependently originated, but there is no dependent origination itself. Nothing comes into being, nor becomes anything else, because pure consciousness, which is self-same and unchanging, is the only thing that ever exists (Gambhirananda, 1990). "This duality, possessed of subject and object, is a mere vibration of Consciousness (*cittaspanditam*). And Consciousness is objectless; hence It is declared to be eternally without relations" (Gambhirananda, 1990, p. 212).

Gaudapada also states: "As firebrand, when not in motion, becomes free from appearances and birth, so Consciousness, when not in vibration, will be free from appearances and birth" (ibid, p. 197).

Sharma (1987), who appears to support vivartavada theory, argues that Vedantic tradition, from its earliest roots in Rig Veda, was monistic and contained this central insight. He quotes the following well-known verses from Rig Veda to support his claim: "Being [*Sat*] is one; wise call it by many names. …Purusha [pure consciousness] is all that is, all that was, and all that shall be" (Sharma, 1987, p. 16). He renders several karikas of Gaudapada as:

> The Self-luminous Self through its own power of illusion imagines itself by itself and it is this self which cognizes the manifold objects. This is the established conclusion of Vedanta [Karika II verse 12]. Just as in darkness a rope is imagined to be a snake, similarly the Self is imagined to be the individual subjects, mental states and external objects. And just as when the rope is known, the imagined snake vanishes, similarly when the nondual Atman is realized, the subject-object duality vanishes at once [Karika II verse 17-18]. (Sharma, 1987, p. 246)

Sharma is a dedicated Vedantin and adheres throughout his work to this viewpoint. He ferrets out pure consciousness as the root of most Indian philosophies, Vedanta and Buddhism especially – even though he at times stretches the interpretation of their key concepts a bit too far in order to accomplish this. In relation to Gaudapada, his interpretation leans toward the

metaphysical, so that it sometimes becomes difficult to discern what kind of actual experience he is describing. The vivartavada viewpoint, like all nondual philosophies, can be understood better if we limit it to the phenomenological description of meditative experience. Then, statements like the above are seen to apply to the fragmenting of the field of experience into subject and object due to the activation of psychological defenses. Shankara's concept of Maya—the power of illusion by which pure consciousness is hidden from itself so that one's true self-identity is obscured, which consists of the concealing and the projecting powers, can be clearly interpreted in this way (Madhavananda, 1982). One can see the non-origination doctrine of Gaudapada from this perspective as stating that the field of experience is always unified, and it is only psychological processes of the mind that make it appear fragmented. Followers of classical Advaita Vedanta, however, would not agree with this interpretation. For them, only pure consciousness, single, self-same, without space and time, and unchanging, exists (Ira Shepetin, personal communication, June 18, 2004)—but this brings them to an insurmountable problem: If only pure consciousness exists, where does maya, the power of illusion, come from?

Two schools of thought have emerged in response to this question. One sees the locus of maya in the individual, and the other in universal pure consciousness. These two viewpoints are associated with Shankara's two main disciples, Mandana and Sureshvara, respectively. Woodroffe (1918) argues that if the locus of maya is in the individual, there would not be one common world on which we all agree. One can also address this question by examining how Advaita

Vedanta understands the relationship between one's unique individuality, or soul, and pure consciousness. According to pratibimba-vada theory, the soul is a reflection of pure consciousness in the mirror of ignorance or maya. Thus, the purer the mirror, the more accurate is the reflection. This view echoes that of Sankhya-Yoga, where pure consciousness as Purusha and nature as Prakriti face and reflect each other. The avachedda-vada theory objects on the grounds that there is no actually existing ignorance or maya as there is no relative reality that can serve as a mirror for pure consciousness. According to avachedda-vada, the soul is a result of the limitations self-imposed upon the pure consciousness due to ignorance (Deutsch, 1973).

As Deutsch states, looking at this issue from a phenomenological perspective offers the most clarity. However, his idea of pure consciousness as being the inner white light is in conflict with other theorists. The experience of white light in consciousness is indicative of the presence of the blissful unconscious substratum (Sansk. sattva guna or, anandamayakosa)—in other words, of the consciousness that is not yet completely pure. Pure consciousness is completely transparent, like space.

Still, regardless of the locus of maya, the problem remains as to the relationship of pure consciousness to phenomenal reality. It is this problem that has given rise to an alternative theory in Vedanta called parinamavada, according to which phenomena are actual modifications of pure consciousness. Adherents of this theory within Advaita Vedanta point to numerous statements in the early Upanishads which describe ultimate reality in this way. For example, the famous

Shandilya Vidya verses from the Chandogya Upanishad state: "This whole world is Brahman…He who consists of mind, whose body is life, whose form is light, whose conception is truth, whose self is space, …encompassing this whole world… This is my self within the heart…" (Radakrishnan, 1995, p. 391). Another example from Chandogya is: "Now next the instruction in regard to the Self (Atman). The Self indeed is below. The Self is above. The Self is behind. The Self is in front. The Self is to the south. The Self is to the north. The Self is, indeed, all this" (Radhakrishnan, 1995, p. 488). From Brihadaranyaka is the statement: "Verily there are two forms of Brahman, the formed and the formless, the mortal and the immortal, the moving and the unmoving, the actual (existent) and the true (being)" (Radhakrishnan, 1995, p. 192). Finally, in the classic Advaita Vedanta text of a later origin, Ashtavakra Samhita, we find: "As waves, foam and bubbles are not different from the sea, so the universe emanating from the Self is not different from It" (Nityarupananda, 1981, p. 19).

Statements like these clearly describe the phenomenological dimension of meditative experience: When the practice of meditation stabilizes pure consciousness, all phenomena appear as transformations of one substance—consciousness itself.

A somewhat different approach is represented by the shakti-advaitavada school of Hindu tantra (Woodroffe, 1918), in particular by the Bengali Shakti Tantra and by the Shaiva Siddhanta as exemplified by Kashmiri Shaivism (Singh, 1998). In response to Advaita Vedanta's claim that the individual bound in worldly suffering is merely an illusory reflection of pure consciousness, like an

image in a mirror, shakti-advaitavada claims that both the individual and his or her suffering are real. They are both transformations of the creative energy of pure consciousness (Sansk. *Cit-Shakti*) – a descent, so to speak, that can be reversed through the force of the same energy functioning in the opposite direction. Thus, the creation of the world and the dualistic experiencing and the liberation from it, are not mere illusions but transformations of the creative energy of consciousness. This creative energy is not something different from the absolute, the way maya is different from Brahman in Advaita Vedanta. Rather, it is inherent in the nature of pure consciousness as its dynamic creative aspect. Thus, everything that exists is ultimately made of consciousness (Woodroffe, 1918).

While clearly an elegant solution to the problem of the relationship of the phenomenal world to pure consciousness, it is precisely these kinds of metaphysical trends that have caused Buddhists, and many Western scholars, to raise the question of reification: Can one say that everything is made of consciousness only because this is how one experiences it in meditation?

Finally, the issue remains, both in the theory and in the practice of shakti-adavitavada, whether the state of the dynamic conscious energy it describes refers to nondual awareness, since it appears that pure consciousness has become entirely lost in the becoming, even if only temporarily.

Nondual awareness as space in Advaita Vedanta. Advaita Vedanta has conveyed the significance of space since the earliest Upanishads, such as in the following verse from Chandogya: "What is the goal of this world? He replied:

Space, for all these creatures are produced from space. They return back into space. For space is greater then these. Space is the final goal" (Radhakrishnan, 1995, p. 352). References to pure consciousness as being space-like in nature when functioning with experiencing also appear quite early. The idea of this similarity is frequently used as a teaching metaphor and is rooted in a particular metaphysical understanding of *moksha* or spiritual freedom, codified in Advaita Vedanta by Shankara. According to him, complete liberation is possible only at the time of death, when the pure consciousness of a realized person merges into the infinite pure consciousness, thus breaking the chain of reincarnations (Jagadananda, 1989). This verse from the Paingala Upanishad summarizes this idea: "A wise man, in whatever place or manner he dies, is absorbed in that place like the all-pervading space. It should be known that Atman [Self] is absorbed as truly as the space in a pot (when broken). Then he attains the all-pervading wisdom-light that is without support" (Aiyar, 1914, p. 53).

We find an elaboration of this notion of space in Kashimiri Shaivism: "For the power of space *(akasa-shakti)* is inherent in the individual soul as the true subjectivity, which at once is empty of objects and which also provides a place in which objects may be known" (Muller-Ortega, 1989, p. 146).

The process of realization of the identity of the individual pure consciousness and the universal pure consciousness, as that of the space inside and outside one's body, has been traditionally described by the metaphor of jars: Individual pure consciousness is like a space inside a jar, while the universal pure consciousness is like the space outside the jar, the space surrounding it.

Realization is comparable to the breaking of the jar, when the space inside and outside mix indistinguishably (Sharma, 1987).

However, properly speaking, there is only one space, which is fundamentally unaffected by the presence or absence of jars. Gaudapada emphasizes this point. For him there is no question of the merging of a soul into the infinite space of pure consciousness, as from the absolute viewpoint, it is already one: "All the souls should be known as naturally analogous to space and as eternal. There is no plurality among them anywhere…" (Gambhirananda, 1990, p. 229).

Fort (1998) points out that the Advaita interpretation of moksha (spiritual freedom)—as the merging of individual pure consciousness into universal pure consciousness at the time of death—has been challenged even within the Hindu tradition itself. He argues that the possibility of being fully liberated and remaining in the body (Sansk. *jivanmukthi)*, as opposed to being liberated after death without a body (Sansk. *videhamukti*), has even been postulated by Shankara himself in his commentaries on the Bhagavad Gita, which thus contradict his own statements elsewhere. This is relevant to the present work because it indicates both the possibility and the necessity of realizing that nondual awareness is pure consciousness functioning with experiencing.

Nondual Awareness Summary

Nondual awareness is pure consciousness functioning with experiences, as a space-like context that pervades the entire field of experience. Nondual

awareness encompasses all states, functions and contents of consciousness. It encompasses the entire field of experience equally, like space that is the same inside and outside, so that the field of experience is not broken into separate subject and objects. Nondual awareness has been described as the inseparable being-awareness-bliss, or alternatively, as emptiness-luminosity-bliss.

In seeing nondual awareness in this way, the present study agrees with the Dzogchen and Mahamudra traditions of Tibetan Buddhism and with the parinamavada doctrine in the Advaita Vedanta tradition of Hinduism. It, however, contradicts those schools of Hindu and Buddhist philosophy (proponents of the vivartavada doctrine of Advaita Vedanta and the Teravada schools of Buddhism) that do not recognize the possibility of nondual awareness or of pure consciousness functioning with experiences. Researching nondual awareness is important for neuroscience because it presents an opportunity to clearly distinguish the neural correlates of consciousness itself from the neural correlates of various states, functions and contents of consciousness.

Research Question

The above review of the literature has covered a wide area of research in the fields of Psychology, Neuroscience and Asian Philosophy. It included Cognitive Neuroscience, Cognitive and Affective Psychology, Neurophysiology, the Tibetan Buddhist traditions of Mahamudra and Dzogchen, and the Hindu traditions of Advaita Vedanta, Sankhya Yoga and Kashmiri Shaivism.

This literature review has established that nondual awareness is pure consciousness functioning with experiences, as a space-like context that pervades the entire field of experience.

Now the research question emerges from the review of literature of both Cognitive Neuroscience and Asian nondual philosophies:

" Do the neural correlates of space in the posterior parietal cortex mediate nondual awareness, in conjunction with the medial and dorso-lateral areas of the pre-frontal cortex?"

CHAPTER FOUR: METHODOLOGY

Rationale for the Research Methodology

There are several methods of research possible for the question of interest in the present study: a) Theoretical research of the relevant literature; b) Qualitative research, either phenomenological, which attempts to get at the essence of the phenomenon or, heuristic, which attempt to get at the subjective quality of the experience; and, c) Quantitative research, which involves gathering and analysis of data obtained through the use of scanning machines, such as fMRI, SPECT, PET, MEG or EEG.

Andersen & Forman (2000) apply Wilber's four quadrant model (Wilber, 2000a) to define four aspects of research applicable to meditation: upper left quadrant representing internal subjective experience for which qualitative research is the most appropriate method, upper right quadrant representing objective cognitive neuroscience for which scientific quantitative research is the most appropriate method, lower left quadrant representing philosophy and theology for which theoretical text research is the most appropriate method, and lower right quadrant representing ritual and cultural aspects for which the social research is the most appropriate method. The topic of this dissertation belongs to the lower left quadrant of philosophy and the upper right quadrant of cognitive neuroscience.

Most of the scientific studies of meditation conducted so far involve either self-report tests or measurements obtained with EEG, PET, SPECT, or fMRI

scanners. Self-report tests, whether those of cognitive or of affective states, have been criticized as somewhat unreliable due to subjective biases, such as subjects wanting to appear successful to prove the value of their particular style of meditation. (Qualitative studies have been criticized on the same ground as well). Scanning machines on the other hand, while more objective, have their limitations. fMRI scanners require subjects to meditate inside the machine that is quite noisy; PET and SPECT scans require subjects to be injected with radioactive tracers; while EEG and MEG machines have poor spatial resolution. At the present time, fMRI appears to be the most promising method for meditation research. However, the research of nondual awareness with fMRI poses a number of challenges, which are related to the nature of nondual awareness meditation, the limitations of the scanners, the methods of data analysis, and the interpretation of the results (Huettel, Song, & McCarthy, 2004; Jezzard, Matthews & Smith, 2001).

Meditation on nondual awareness is traditionally described as resting the mind in its natural state, without any effort (Rabjam, 2001b). This implies first, that the mind is at rest, or relaxed and has returned to its root state of open-ended awareness. Second, it implies that there is no effort and no intentional focused activity present. These two characteristics of nondual awareness present a problem for fMRI data analysis because most fMRI experimental paradigms are based on comparing the state of the brain at rest vs. the state of brain during a specific activity that is being examined. This is done in order to obtain "activations"—indications of which areas of the brain are more active during the

specified task than during the rest state. The lack of specific activity during nondual awareness, which is experienced as an effortless resting quality, make the task of obtaining clear activations within this paradigm difficult. In addition, the stabilization of nondual awareness that occurs in long-term practitioners may cause permanent changes in the way their brain functions during rest. The meditative state for these practitioners becomes integrated to such an extent that even while resting and doing nothing, they are still meditating. For these reasons, developing an experimental paradigm that would reliably show activations of the areas of cortex during the nondual awareness meditation has been a challenging process, as seen by the difficulty of Davidson's team (2004b) in defining the state of rest in relation to nondual awareness.

As mentioned above, the most important limitation of the MRI equipment is the loud noise generated by the radio frequency coils, which can interfere with more subtle cognitive tasks such as meditation. A lesser problem, but nevertheless an issue for some subjects, is that the meditation has to be done lying down. These issues have led some reviewers to question whether the meditation done in the MRI scanner is the same as the meditation done in one's regular place of practice (Andresen, 2000). In addition, distortions in the image acquisition can create artifacts such as blurring of the anatomical boundaries or missing areas of brain tissue.

The processing of the fMRI data involves several common steps that present unique challenges (Frackowiak, Friston, Frith et al. 1997). The process of co-registration of functional and anatomical data can be imprecise, so that

functional activations can show even outside of the anatomical brain tissue. The fact that the human cortex varies considerably in shape and size from individual to individual presents a more significant problem for the accurate localization of activations (Brett, Johnsrude & Owen, 2002). Spatial normalization, which involves morphing the brain of a subject to fit a standard brain form, and locating the areas of activation according to Talairach coordinate system (Talairach & Tournoux, 1988), may not be able to match localizations between the subjects.

The noise that the brain generates, and the enormous amount of data that has to be analyzed, creates a problem of multiple comparisons (Huettel et al, 2004), where a type I error of labeling a voxel active when it is not, can be committed. The standard solution is to lower the p value. In the preliminary data presented in the Apendix, the p value was lowered to far below the statistically significant $p<0.05$, to $p<0.000003$. Furthermore, cluster-size thresholding, another method of solving the problem of multiple comparisons, was also applied, and the voxel significance was raised to 8.

Interpreting the results of fMRI data analysis poses a number of unique challenges as well. BOLD activations do not directly indicate the contents of consciousness (Revonsuo, 2001). In addition, most of the higher associative areas of the cortex, such as those involved in meditation have been found to be active during a number of different tasks. For example, the dorsolateral pre-frontal cortex (BA 46) is involved in working memory (Cabeza & Kingston, 2001), abstract thought (Snow, 2003), and feelings of happiness (Davidson, 2004a). In a personal email discussing the fMRI scans of nondual awareness meditation

presented here, Bernard Baars wrote: "All of the regions showing higher activation have multiple functions. How do you know that they are causal of advanced meditation states, rather then a cognitive style correlate for the kinds of people who self-select to become long-term meditators? Or perhaps they result from ancillary kinds of training associated with long-term meditation?" (Baars, 2005b).

These issues demonstrate that in order to answer my research question within the interdisciplinary approach, the best method at the present time is the theoretical research of the literature in the fields of Cognitive Neuroscience and Asian Philosophy (Dzogchen and Mahamudra of Tibetan Buddhism and Advaita Vedanta of Hinduism).

My sources for conducting theoretical research were PsychInfo and PubMed, databases, UI&U Gary library, and Rutgers University Dana library. The search of the PsychInfo database for the available period of 1806-2005 yielded the following number of results (hits): 'meditation' – 2619; 'nondual awareness meditation' – 0; 'awareness meditation' – 4; 'meditation fMRI – 1. The search of the PubMed database for the available period of 1951-2005 yielded the following number of results: 'meditation' – 1196; 'nondual awareness meditation' – 0; 'awareness meditation' – 66, of which 63 were related to psychotherapy or stress-reduction; 'meditation fMRI' – 7. From these results it is evident that the subject of my study, neural correlates of nondual awareness, is insufficiently researched topic.

A meta-analysis of meditation research on the topic of my study cannot be done at the present time, as there are no published studies of the scientific research of the neural correlates of nondual awareness. Likewise, there are only a few studies of pure consciousness that have been published so far, those of TM conducted by Travis and his colleagues.

A number of other methodological issues have emerged in meditation research in recent years due to the intersection of the various disciplines involved. In a recent reply to criticism of meditation research in the journal *Nature*, Davidson (2005) states that meditation research is still in its early stages of development. Shapiro & Walsh (2003) list a number of issues in design of meditation studies, most notably lack of randomization, lack of follow-up, and imprecise measurements of constructs. They make recommendations for insuring the quality of design, such as: differentiating between types of meditation, correlating length of meditation to its quality, short-term and long-term follow-up assessments, component analysis of meditation process, and including the qualitative data. Caspi & Burleson (2005) in their review of issues in meditation research emphasize the correct matching of design to the type of question researched. They group all meditation studies into two types: efficacy-effectiveness types, which attempt to research the effects of meditation on a particular condition or aspect of cognitive functioning, and explanatory types, which seek to understand the underlying mechanisms of meditation. The present study belongs to the second type of meditation studies.

The following issues in meditation research, while not directly related to the theoretical research conducted here, provide relevant background information that facilitates appreciation of the subject.

First Person/ Third Person Methodologies

This issue can be defined as: what is the correct relationship between the objective observation of the subject's mental states and a subjective report of one's experience during meditation. The fundamental challenge of meditation research has been the reluctance of sciences to accept the first person subjective reports as valid data (Wallace, 2003). There are, of course, many good reasons for this, as a number of well-known studies have shown, yet without relying on the subjective reports there is no way to correlate the external observation to the corresponding internal phenomenal experiences (Shear & Jevning, 1999). Attempting to address this issue, the late Francisco Varela of the National Center for Scientific Research in Paris, France, created a new field he termed Neurophenomenology. He writes: "[The] central purpose of this…first person methodology is to provide the basis for a *science of consciousness which includes first-person, subjective experience as an explicit and active component*" (Varela & Shear, 2002, p.9).

Cross-cultural Issues

The problem of bracketing the cultural context within which the technologies of meditation have been developed is an ongoing issue in the Asian philosophy studies, and, more recently, in the cognitive neuroscience as well.

Stutchburry (1998) in reviewing the use of Tibetan monks for the study of inner heat practice conducted by Herbert Benson, brings attention to the issues of taking meditation out of its religious and environmental context. The subjects reported that the experience of being flown to a different part of the world and treated in an objectifying manner was disorienting and that it interfered with their ability to meditate. Andresen (2000) underscores the technical difficulties of testing some of the most interesting types of meditation, such as the Dzogchen practice of Togel, due to the special body positions that have to be maintained while meditating.

Taxonomies of Meditation

The vast number of different meditation techniques that generate different states of consciousness, complicates the task of a researcher who needs to have clarity as to what exactly is the subject doing when meditating. Systematizing meditation techniques and the phases of the progress in meditation has been a perennial project of Asian contemplative philosophies. Most often, meditations have been classified on the basis of the object of focus, such as the breath, visualization, mantra-chanting, compassion-devotion, intellectual inquiry, self-identity, etc. Current trend in meditation research literature is to see all meditation techniques as belonging to one of the two groups: 'concentration' style, where attention is held on an object of focus; and 'awareness' or mindfulness style, where attention is open-ended without any specific focus (Cahn & Polich, in press; Dunn et al., 1999). For the purpose of this study, different meditation techniques have been summarized into four categories, according to the resultant

state of consciousness: a) absorption (Sansk. samadhi; Tib. shamata; b) insight-wisdom (Pali vipassyana; Jap. kensho; c) pure consciousness (Sansk. Atman; Tib, od-sel); and, d) nondual awareness (Tib. rig-pa). My research is focused on the last two categories.

Finally, the Dalai Lama has raised an important issues regarding methodology of meditation research, which has to do with the relative complexity of the human brain and consciousness. He emphasized that the variables determining the unique nature of each individual's mind are so great that it is not possible to find uniformities and laws that will have the same exactness for human consciousness as those for physical phenomena (Dalai Lama, 1997).

CHAPTER FIVE: ANALYSIS

Based on the previous review of the literature and other selected sources, this chapter presents the theoretical research of the question : Do the neural correlates of space in the posterior parietal cortex mediate nondual awareness, in conjunction with the medial and dorso-lateral areas of the pre-frontal cortex?

The review of the literature in the Asian nondual philosophies of Advaita Vedanta, Mahamudra and Dzogchen, has established that nondual awareness is pure consciousness occurring with experience. For the purpose of the theoretical analysis, I will first examine the topic of pure consciousness and nondual awareness in these Asian philosophies in more detail.

Pure Consciousness

Pure Consciousness in Relation to States of Consciousness

Approaches to describing pure consciousness in Indian traditions, as well as in Tibetan traditions, can be classified into two general categories: (a) approaches via states of consciousness, and (b) approaches via functions of consciousness. In this context, *states of consciousness* refers to the three universal experiential states of waking, sleeping and dreaming.

In Advaita Vedanta, describing pure consciousness via states of consciousness appears in the earliest Upanishads and reaches its full form in the Mandukyo Upanishad (c. 300 B.C.E.), where pure consciousness is distinguished from the three states of waking, deep sleep and dreaming and is designated as a

fourth state (Sansk. *turiya*): "This Self is Brahman. The Self, as such, is possessed of four quarters" (Gambhirananda, 1990, p. 9). The following table, developed according to the Mandukyo Upanishad, names the four states of consciousness and correlates these to four experiential states and to the three levels of reality: matter, energy and consciousness.

Table 1: States of Consciousness in Advaita Vedanta

gross	subtle	causal	transcendent (fourth)
waking	dreaming	deep sleep	meditative absorption
matter	energy	(non) consciousness	pure consciousness

In the Advaita Bodha Deepika or The Lamp of Non-dual Knowledge, we find an epistemological explanation of the above taxonomy:

There is the triad composed of the knower, knowledge, and the known. Of these, the knower is the subject; knowledge is the intellect; and the known the objects. This triad arises and flourishes in the waking and dream states and merges in the insentience of the deep sleep state. That which, remaining as the sole unchanging consciousness, illuminates and causes the appearance of all these three states, is the witnessing Self. Discern it and realize it (Saraswathi, 2003, p. 70).

Fort (1982) traces the origins and development of the theory of four-fold reality, from its early stages in the first Upanishads to its contemporary

developments in transpersonal psychology. He understands the relationship between turiya, the fourth state, and Brahman as being one of identity, restating essentially the idea of the identity of Atman and Brahman. In addition, he says that turiya relates to the states of consciousness as Brahman does to the different levels of the creation. He also identifies a gradual change in this concept: "In some later texts, notably the Yogavasishta and certain minor Upanishads, turiya itself begins to appear as a stage in meditation, albeit an exalted stage. Turiya as the highest meditative stage does not contradict turiya as substratum, for this "stage" might be our true, basic nature; however, the emphasis is quite different, and when turiyatita [the fifth stage, literally: "beyond the fourth"] is introduced, turiya is no longer even the highest stage" (Fort, 1982, p.10).

As Fort claims, one can see the parallel in the relationships between turiya and the other three states of consciousness – between Brahman and the three worlds: physical, subtle and causal. However, Brahman understood in this way applies only to the transcendent aspect, not to the immanent, and not to both the transcendent and the immanent.

Wilber (2000a) equates turiyatita with the realization of pure consciousness that encompasses all experience – in other words, with nondual awareness. While this is the correct interpretation of the term, whether this is the meaning given to it in the various later Advaita texts is debatable.

Fort (1982) also identifies another problem in this approach to the taxonomy of consciousness, that of the status of consciousness in deep sleep (Sansk. prajna). There is a difference between Brihadaranyaka and Chandogya

Upanishads in this respect, which indicates an evolution of understanding with time. The former Upanishad regards deep sleep as a more positive state, full of bliss, and assigns to it an almost absolute status identical to pure consciousness. In the Chandogya Upanishad, there is a more precise differentiation of pure consciousness from the consciousness in deep sleep. It sees deep sleep to be a state of ignorance or un-consciousness, even though it is object-less like pure consciousness. The Mandukyo Upanishad classification (see Table above) clarifies this issue most completely.

In addition, it is much easier to understand these types of issues accurately on the basis of personal meditation experience: Pure consciousness is present in deep sleep but obscured by the state of basic unconsciousness, also known as the unconscious substratum (Sansk. anandamayakosa). When one wakes up within a deep sleep or within a state of meditative absorption, which is like deep sleep, the pure consciousness recognizes itself.

Tibetan Buddhist tradition also has a taxonomy of pure consciousness based on states of consciousness. These states include death, in addition to the three above mentioned states of waking, dreaming and deep sleep, and in some cases, orgasm (Dalai Lama, 1996). The main distinction between this Tibetan Buddhist classification and that of the Advaita Vedanta system is that pure consciousness is usually not seen as a separate fourth state, but rather as the transformation of the third state. There is some evidence, however, that the Dzogchen tradition is closer to Advaita Vedanta in its interpretation of this point,

as it clearly separates natural pristine awareness from basic unconsciousness or *alaya vijnana* (Rangdrol, 1990).

Table 2 outlines various states of consciousness and their relationship to pure consciousness (clear light) according to Tibetan Tantric tradition.

Table 2: States of Consciousness in Tibetan Buddhism

very subtle	subtle	coarse
deep sleep	dreaming	waking
dying	transition	rebirth
clear light	illusory form	emanation
emptiness	luminosity	bliss

after Cozort (1986)

The categories of clear light, illusory form and emanation correspond respectively to Dharmakaya or the truth body, Sambhogakaya or the enjoyment body, and Nirmanakaya or the emanation body. This theory of "Buddha bodies" appears first in the Lankavatara and Avatamsaka Sutras and figures prominently in the Yogachara philosophy upon which early Buddhist Tantras are based (Traleg, 1993). Some understand that the cosmological view of the hierarchies of heavenly realms (Kongtrul, 1995) implies that these bodies are distinct realms and levels of realization that have to be transcended in sequential order from the more coarse to the more subtle (Wilber, 2000a). It is more accurate to see these bodies either as dimensions or as manifestations of pure consciousness itself. As Situ

Rinpoche points out: "Sambhogakaya is the Sambhogakaya of the Dharmakaya; and Nirmanakaya is the Nirmanakaya of the Dharmakaya" (2000).

Pure Consciousness in Relation to Functions of Consciousness

Outlining the progressive increase of subtlety in function of consciousness from perceptual consciousness to pure consciousness is common to both Hindu and Buddhist traditions. It constitutes the second approach to the taxonomy of consciousness, that via the functions of consciousness.

The earliest versions of this taxonomy appear in the Hindu Sankhya-Yoga tradition, and these well predate Buddhism (Aranya, 1983). The Vedanta tradition adopted this system most notably in the *Bhagavad Gita*, even though some argue that its main ideas, like the theory of the three gunas, have been borrowed from the Chandogya Upanishad, which arguably preceded it (Sharma, 1987). So, while Sankhya-Yoga is not directly pertinent to the present study of Advaita Vedanta, its influence on it in this respect is undeniable, and hence, I am briefly including it in this discussion.

Sankhya-Yoga outlines twenty-five categories of reality in its system (Virupakshananda, 1995):

1. *Purusha* or spirit – which is pure consciousness, the silent uninvolved witness which is unaffected by the evolutes of prakriti (defined next).
2. *Prakriti* or the un-evolved, unconscious primordial nature – out of which all the following categories of existence evolve, and which is

composed of the three modes (*gunas*): *sattva* or harmony, *raja* or agitation, and *tama* or inertia.

3. *Buddhi* or the discriminating reason and will.

4. *Ahamkara* or ego – also described as the I-ing consciousness which appropriates all experiences to oneself.

5. *Manas* or cognizing mind – which organizes sensory perceptions.

6-10. Five j*nana-indriyas* or sense organs.

11-15. Five *karma-indriyas* or organs of action.

16-20. Five t*anmattras* or subtle elements.

21-25. Five b*utthas* or gross material elements.

Hariharananda Aranya, in his translation and commentaries on Patanjali's Yoga Sutras (1983), underscores the epistemological thrust of this taxonomy. In this he echoes Ishvara Krishna's classic treatise *Sankhya Karika.* There is a great deal of affinity between this approach to the taxonomy of consciousness and the one found in Buddhist Yogachara philosophy, even though, as seen below, they differ fundamentally in their attitudes toward metaphysics.

The Yogachara school of Buddhist philosophy, also known as Cittamatra or the mind-only philosophy and attributed to Vasubhandu (c. 400 C.E. the younger brother of a noted Mahayana proponent named Asanga), forms in many respects the core of the Tibetan Tantric tradition, especially in the Kagyu sect of Tibetan Buddhism (Traleg, 1993). Some of the main ideas of this school are: the

"three natures"—the analysis of phenomena as having three levels of being (imaginary, dependent and ultimate); the theory of alaya vijnana—the foundational unconsciousness which serves as the storehouse of memories; the eight-fold division of consciousness; and most significantly, teachings on Buddha nature—the innate enlightened mind within all beings.

This school's taxonomy of consciousness is uniquely positioned between two groups: the older Hindu taxonomies based on Sankhya-Yoga, and the newer ones, such as those found in the Buddhist Tantras. The eight consciousnesses of Yogachara are: *Alaya vijnana*—the unconscious storehouse of impressions; *Manana vijnana*—the ego; *Mano vijnana*—the sensory mind; and 5 sense consciousnesses (Trangu, 2001).

Two significant issues arise with respect to this taxonomy. The first is the question of whether the original Yogachara philosophy as established by Vasubhandu recognizes pure consciousness at all. The second is the claim made by its critics that Yogachara is a form of mental idealism.

Kochumuttom (1999) regards Yogachara as pluralistic realism rather than mental idealism; he interprets the thrust of Vasubhandu's writings to be the denial of the ontological dimension of both subject (consciousness) and objects (matter). Kochumuttom does not recognize the possibility of pure consciousness. In analyzing Vasubhandu's term vijnana-parinama or the transformation of consciousness, he points to parallel usage in the word parinamavada in Vedanta, which signifies an actual change in the substance, rather than an illusory change in appearance only, for which the term vivartavada is used. He sees

transformations of consciousness as concepts broadly categorized into atmans (subjects) and dharmas (objects). Based on his interpretation of vijnana-parinama, he regards these changes in the substance of consciousness to be the real evolutes of consciousness and claims that "consciousness has no existence apart from its concepts" (p.133).

However, Kochumuttom does not equate consciousness with Buddha nature. Rather, by interpreting Vasubhandu's doctrine on the three natures as outlined in Tri-Svabhava-Nirdesha, he regards absolute nature as a mere absence of subject-object duality. However, this analysis does not follow its course far enough: Buddha nature is pure consciousness (awareness-as-such) itself, for which this absence of subject and object is a mode of cognizing. One can speak of such-ness (Sansk. *tathata*) as the overall way of being of all things, but there has to be some type of consciousness that realizes it. Thus, the exact nature of this consciousness or awareness can be questioned, but not its existence. (The subsection on objections to the idea of pure consciousness further explores this issue.) In his translation of the same texts, Garfield (1997) appears to agree with this view when he translates verse 34 as: "In the same way, through the non-perception of duality/There is the vanishing of duality./When it vanishes completely,/Non-dual awareness arises" (p. 143).

Of particular interest in Kuchumuttom's work is his comparing of the taxonomies of consciousness in Sankhya and Yogachara as they appear in Ishvarakrishna's Sankhya-Karika and Vasubhandu's Trimshatika (1999, p.221). In particular, he correlates *Prakriti* with *Vijnana*, and *Buddhi* with *Alaya-vijnana*.

Kuchumuttom correctly identifies the main difference in these two approaches – that Sankhya is an ontological and metaphysical approach in which the processes of consciousness give rise to the material universe, while Yogachara is a psychic or epistemological approach, which does not extend the process of cognition into the creation of the world. The question remains as to whether this implies that Yogachara does not recognize any reality outside of mental processes.

There are two problems with Kuchumuttom's way of correlating these two approaches. First, it seems obvious that alaya-vijnana (the foundational unconsciousness) relates to the idea of prakriti, the unconscious nature. D.T. Suzuki describes alaya-vijnana as the dimension where "habit-energy" or "memory" lie and remain preserved, and as all "all-conserving consciousness. This consciousness alone has no power to act by itself. It is altogether passive, and remains inactive until a particularizing agency touches it" (1932, p. 5).

Second, Sankhya's concept of buddhi– the discriminating intelligence and intentionality-will, and the unmodified "I-am-ness" – cannot equate to the foundational unconsciousness of alaya-vijnana, which stores impressions of experiences. What then is vijnana or consciousness in Yogachara? Here arises the main problem with interpretations of Yogachara.

Most authors agree that the Yogachara teachings on Buddha nature, which represents the third turning of the wheel of Dharma, are based on the Lankavatara and Avatamsaka sutras (Gyamtso, 2004). Lankavatara, which contains the most clear exposition of Buddhist mental idealism, explicitly states that ultimately there

is nothing but consciousness, which it calls *citta* (Suzuki, 1932). It states that vijnana, on the other hand, is a moment of dualistic consciousness. It regards alaya-vijnana as the deepest level of consciousness, which becomes transformed into Buddha nature or Universal Mind, as Suzuki translates it, when awakened. Some Tibetan tantric teachings contain this interpretation as well (Trangu, 2002). However, the Dalai Lama (1997b) offers a different explanation. He compares consciousness to muddy water – that water is pure in its nature and is always present regardless of contaminants, and its purity is revealed when the sediments settle. Likewise, clear light awareness or pure consciousness is not created as a transformation of something else, but this is simply revealed after confusion is cleared.

Asanga's well-known work "Maitreya's Distingushing Phenomena and Pure Being," describes ultimate consciousness in Yogachara as "wisdom devoid appearance… [which] is itself the clear light, all-pervading like space" (Gyamtso, 2004, p. 155). Chinese sources such as Chang also believe that Yogachara (as well as Zen) considers self-witnessing or self-awareness to be pure consciousness: "This, *chih,* or self-awareness, is intrinsically non-dualistic. It can be aware of itself, and can be aware as such without any outer object" (Shear & Jevning, 1999, p. 194).

As mentioned, the Dzogchen tradition of Tibetan Buddhism also clearly separates alaya-vijnana and Buddha-nature (Rangdrol, 1990). Thus, if one adds Buddha nature (awareness-as-such) as a ninth consciousness to the traditional

eight of Yogachara, a more accurate chart of correspondence between Yogachara and Sankhya classifications of consciousness appears:

Yogachara	Sankhya
Buddha nature	Purusha
Alaya-vijnana	Prakriti
"I"-consciousness	Buddhi & Ahamkara
Mental consciousness	Manas
5 sensory organs	5 sensory consciousnesses

In addition, there are some differences between the Buddhist notion of Buddha nature and the Sankhya notion of Purusha, which, among others, have to do with how and if pure consciousness manifests itself at the level of energy and form, but exploring these differences is beyond the scope of this dissertation. This approach allows for the critique that the Buddha nature as described here is more similar to the Vedantic notion of Atman than it is to the idea of Nirvana in early Buddhism. However, this is a problem only for Buddhist philosophy schools, not for someone having the actual experience of pure consciousness. As Tsultrim Gyamtso Rinpoche says:

> Mind is empty of such distinctions between itself and what is other to it. If the meditator were to rest his mind in its own nature and see this emptiness, then all confusion would disappear and the mind would be bright and clear and self-aware. This mind is called the self-illuminating

self-aware mind (Tib. shes pa rang rig rang gsal). It is called this because it is the mind experiencing itself (Tib. rang gis rang myong ba) (2001, p. 35.).

The main traditional argument against Yogachara, which itself was a corrective movement against an excessive emphasis on emptiness in early Madhyamaka, comes from the later Madhyamaka writers. Their critique centers on the mentalistic interpretation of Yogachara—according to which the fact that what is experienced are mental representations, is a proof that the external world does not exist (Dalai Lama, 1997a). While this is an extreme interpretation of Yogachara, the actual status of the external world is unclear in the Yogachara philosophy (M. Martin, personal communication, February 18, 2004). Madhyamaka, especially the later Prasangika development of it, does not deny the existence of the external world. It only specifies the manner in which things abide. It denies the existence of the unconscious substratum alaya-vijnana and claims there is no need to establish the existence of a repository for memory traces, since conditioned experiences arise as mere mistaken cognitions (Dalai Lama, 1997a).

This second part of the argument is the main weakness of the Prasangika approach, and it stems from the need to avoid a notion that there is consciousness as such. Clearly, there is a level of consciousness that functions as the repository of memory, regardless of how one may conceptualize it. The relativistic nihilism in which the Madhyamaka position often finds itself was ameliorated by later

developments in Tantric Buddhism and Dzogchen. The position of the Gelukpa sect today is that Madhyamaka philosophy is the highest expression of Buddhist teachings at the level of sutras, while the teachings about the clear light in tantras and Dzogchen (Dalai Lama, 1996) express the more accurate truth.

Herbert Von Guenther (1977) offers an analysis of the issue of mentalism by comparing the Kagyu and the Nyingma schools of Tibetan Buddhism. He suggests that the Dzogchen tradition is correct when stating that the world of dualistic experience arises as a misapprehension out of the ground of pure awareness in which all things are revealed in their suchness.

In the later medieval times, the development of various taxonomies of consciousness proliferated greatly, and many sects created their own elaborate versions that distinguish their unique teachings. For example, Hindu Shaiva Siddhanta tradition, as exemplified by Kashmiri Shaivism of Abhinavagupta, elaborates upon the Sankhya system by positing a number of categories between pure consciousness and basic unconsciousness, which represent the gradual progress of the descent into duality. Buddhist tantras transmitted to Tibet in the 11th to the 13th centuries A.D. have a taxonomy based on the sequence of visions that appear in progressive stages of absorption of the subtle energy into the central channel, until the final clear light of awareness dawns (Dalai Lama, 2003). In his translation of Guhyasamaja Tantra, Wayman (1999) suggests that this sequence has roots both in the Upanishad tradition, especially in the Chandogya Upanishad, and in the Sankhya-Yoga theory of gunas.

Arguments Against the Existence of Pure Consciousness

Once one realizes pure consciousness, or clear light awareness, there can be no doubt about its existence. Until then, as the ancient metaphor says, all arguments are like arguing about the taste of a mango fruit by those who have never tasted a mango. However, the mystical approach alone cannot validate the existence of pure consciousness. Conversely, a mystic or yogi could claim that no argument, no matter how thorough, can ever be proof of pure consciousness, and that one's personal experience is ultimately the only valid proof. Over the centuries, numerous logical arguments for and against the existence of pure consciousness have been advanced (Isayeva, 1993). As mentioned in the introduction, formal logical arguments are beyond the scope of this dissertation. Below is a brief review of the main arguments against the existence of pure consciousness – from both traditional and contemporary sources.

Traditional arguments against the existence of pure consciousness relate to four categories: a) materialism—which limits reality to sensory experience, b) relativism—which sees all that exists as being an impermanent, causally linked flux, c) non-conceptualism—which sees pure consciousness as a mere reification, and d) self-nature—the question of whether there is a self-sense inherent in pure consciousness.

The materialist philosophy arose in India sometime after the early Upanishadic period, and before the appearance of Buddhism. Its chief feature is the belief that all of reality is material, resulting from the combination of elements. One can know this material reality only through sensory perceptions,

and consciousness is a natural byproduct of matter, like alcohol is of fermented fruit (Sharma, 1987). Thus, materialist objections are not directed only at the existence of pure consciousness, but also more broadly directed at all phenomenal experiencing. Aside from the purported denial of the theological and metaphysical structures postulated by early Vedanta and Sankhya-Yoga, and the social implications of this, the ancient Indian materialists found no value in inner experience, save for sensory pleasures. One could say that this denial of the value of inner phenomenal experience is common to many of today's staunch materialists. Loomis (1992) refers to the belief that one is conscious of the actual physical objects one is perceiving as naïve realism. Rather, we are conscious of the representations formed in our brains from sensory inputs, and we construct "pictures" of the world around us through the process of distal attributions (Loomis, 1992). The representations themselves are highly malleable, and so are our experiences of the world. This point has been emphasized both by the Madhayamaka and Yogachara philosophies of Buddhism and later, by the medieval synthesis of Yoga and Vedanta, as found in Yogavasistha (Venkatesananda, 1984).

The essence of the relativistic position is that reality is an impermanent flux of causally linked phenomena, without any enduring absolute dimension (Sharma, 1987). The main representatives of this position against the existence of pure consciousness are the early schools of Buddhist philosophy, Vaibhashika and Sautrantika. They believe that all phenomena belong to five *skhandas* or heaps (form, feeling, perception, mental constructs, and consciousness), and that

phenomena are interconnected through the causally linked chain of dependent origination, described by the Buddha in his second noble truth (Rahula, 1974). There is no pure consciousness or unchanging self behind this flux. Rather, there is a stream of consciousnesses (Sansk. vijnana), which are momentary cognitions arising simultaneously with the cognized phenomena. Isayeva (1993) correctly identifies the central issue in the argument between this view and Advaita Vedanta, which is the status of the inner mental organ (Sansk. *antah karana*) in relation to atman or pure consciousness. Shankara rejects the idea that consciousness is only streams of momentary cognitions. In his commentary on the Brahma Sutras, he emphasizes that there must be a subject who realizes this momentariness (Vireshwarananda, 1993).

The non-conceptuality argument against pure consciousness comes mainly from the Madhyamaka schools of Buddhist philosophy. There are basically two levels to this argument – the metaphysical and the methodological.

The metaphysical level concerns what is arguably the central difference between early Buddhism and Hinduism, or any theism for that matter – namely, the nature of ultimate truth, whether there is a permanent ground behind the changing flux of experiences or whether reality is groundless

As seen in the review of literature section, Vedanta and most Hindu philosophies posit an unchanging background of pure consciousness upon which the phenomenal world arises like images on a movie screen. Advaita Vedanta regards pure consciousness as ultimately real, eternal and independent of experienced objects and events. There must be an unchanging witnessing

consciousness that experiences the continuum of cognized moments, as well as the appearance and disappearance of the subject-object duality.

Madhyamaka schools of Buddhist philosophy, on the other hand, deny the existence of any type of ground or foundation of phenomena (Rana, 2001). This view is that subject and object are dependently arising – that the subject is a continuum of moments of cognition that arise in dependence on the objects being cognized (Gyamtso, 2001). There is no enduring subject, nor any enduring pure consciousness in the background of experience. The perception of pure consciousness as a foundation or substratum is merely a mistaken inference. While more extreme interpretations of Vedanta (see the next section) claim that nothing exists but pure consciousness, the Buddhist philosophy regards this view as an inconsistency in reasoning. It recognizes that the subject-object duality is an illusion and that, as an illusion, both subject and object are mutually dependent, yet it claims it is possible to have an absolute subject without any objects (Goode, 2000).

The methodological level concerns reification as a conceptual activity that has to be abandoned if one is to abide non-dually. It sees enlightenment as the letting go of, or the relaxation of, the mind's function of dividing experiences into subject and object. It is a cessation of reifying both subject and object as inherently existing (Gyamtso, 2001). In his famous work Mulamadhyamikakarika (Garfield, 1995), Nagarjuna establishes that all things are empty of independent existence and are ungraspable through concepts, including emptiness itself. He develops a negation of the fourfold status (existence, nonexistence, neither

existence nor nonexistence, both existence and nonexistence) as a logical method to facilitate letting go of reifications.

In relation to pure consciousness, the problem with reification is that as soon as one "decides" that pure consciousness is some "thing," one tends to move away from direct experience of pure consciousness into the realm of the conceptual mind. It is this problem that leads to two misunderstandings prevalent among followers of Madhyamaka philosophies. The first misunderstanding is the claim that nothing definitive can be said about ultimate reality, since whatever is said is merely a concept. Zen expresses this belief as mistaking a finger pointing at the moon for the moon itself. The second misunderstanding is the conclusion that nothing exists. This type of nihilism is not of the same kind as that found in the extreme interpretations of Vedanta and Yogachara, where the reality of external things and phenomena is denied because they are seen, in the final analysis, to be nothing but consciousness (Sharma, 1987). Here the claim that nothing exists extends to consciousness as well: Since everything is either a subject or an object, and subject and object are mutually dependent, and neither is real, then nothing exists. To the question "What then is this here and now?", these philosophers reply with thundering silence, of which they are so proud. Nevertheless, the truth they express in this way is a humble one – that reality is not graspable through concepts. In Tibet, a school of philosophy calling itself Shentong or Yogachara Madhyamaka arose in an effort to correct these types of nihilistic interpretations of emptiness. "Shentong contention is that the experience

of the complete freedom from the conceptual contrivance must also be the experience of the Clear Light Nature of Mind" (Gyamtso, 2001, p. 68).

The last traditional argument—the self-nature argument – is the most subtle. It is not really an argument against the existence of pure consciousness or clear light awareness, because both sides—the Dzogchen and Mahamudra traditions within Tibetan Buddhism, and the Advaita Vedanta, Shaiva Siddhanta and even Sankhya-Yoga traditions within Hinduism—recognize pure consciousness. Rather, the argument is whether there is a sense of self inherent in pure consciousness.

The pre-Buddhist Upanishads, as seen previously, regard pure consciousness as one's most subtle and most real self—Atman. Tibetan traditions, on the other hand, regard the clear light as entirely empty and see any sense of self, however subtle, to be the result of the conceptual activity of the mind imputed onto the clear light (Dalai Lama, 1997b). They base these statements both on the experience of meditative absorption (here accusing Hindu meditators that their experience of absorption is not deep and clear enough to pass beyond alaya-vijnana which contains the seed of self-sense, while Hindus respond that the Buddhist's realization is not deep enough to cross the abyss of emptiness and reveal the true self), and on one of the central tenets of Buddhism, the nonexistence of self.

However, the actual meaning of the denial of the existence of self in Buddhism is a matter of debate (Albahari, 2002; Hamilton, 2001). Buddha's famed statement that "All phenomena are not-self" can be interpreted in a number

of ways. As Hamilton points out, it originally may not have been an ontological statement about the nonexistence of self. Rather, it may be saying that the self is present, but that its exact nature needs closer examination. A Vedantic argument, on the other hand, would be that there is no contradiction here with the early Upanishads, for they state that all phenomena, including skhandas, are different from Atman or pure consciousness (Albahari, 2002). Hamilton (2001) points out that the shift that Buddhism brought to Indian philosophy is essentially a shift from emphasizing ontology toward emphasizing epistemology. She is, however, overlooking the fact that any philosophy that is as fundamentally soteriologically oriented as Buddhism must have an ontological core, even if it doesn't acknowledge this overtly.

In light of traditional arguments, contemporary Western objections to the existence of pure consciousness are quite interesting. Shear and Jevning (1999) group Western objections into the following categories: a) procedural—centering on the question of how one can turn awareness away from all the contents and functions of consciousness and direct it toward itself alone, and at the same time follow a prescribed procedure for meditating; b) ineffable—centering on the question of how there can be a conscious experience that is ungraspable or unimaginable, as traditional accounts claim; and c) constructivist —centering on the idea that pure consciousness is merely a cultural construct.

One can easily answer the procedural objection, because it is due to lack of familiarity with the mechanism of meditation. In beginning stages of using any meditation technique, there is a period of self-monitoring to see if one is doing the

technique correctly. However, this itself is not the actual meditative state. Shear and Jevning (1999) point to the traditional markers of reaching absorption into pure consciousness, which modern neuroscience research verifies: temporary spontaneous cessation of breath; decrease in hepatic and renal blood flow with simultaneous increase in cerebral blood flow; EEG synchrony; and the cessation of all internal experiences except for consciousness itself.

Ineffability or ungraspability of pure consciousness is a constant theme in both Buddhist and Hindu literature. Yet, one knows when one has this experience because consciousness knows itself: Its most fundamental property is that it is conscious of being conscious; it is a self-knowing awareness (Rangdrol, 1990). Only afterward can one think about it and conceptually classify it. However, as seen in the following section on non-dual awareness, pure consciousness can be present with all experiencing and thinking—but the thoughts or images and symbols are not identical to the realization of pure consciousness.

The well-known Katz-Forman debate exemplifies the constructivist objection—the details of which are beyond the scope of this dissertation. Briefly, the essence of Katz's argument (1978) is that all experiences are cultural constructs occurring in the context of the culture to which the experiencer belongs. Thus, there can be no "pure consciousness" common to everyone. Furthermore, all experiences are propositional in nature, built from verbal concepts, memories, re-cognitions, and constrained by beliefs, expectations, symbols, and rituals. Forman (1989, 1998) agrees that there is a constructed and conditioned level of experience; however, pure consciousness has no empirical

phenomenal content of any kind, so it cannot be a construct. He points to the obvious fact that consciousness precedes linguistic constructs: To learn a language, one first must be conscious. To a certain extent, this debate is similar to the above-mentioned traditional argument about non-conceptuality.

Summary

The conclusion of the above analysis is that pure consciousness is the experience of consciousness without content, and that it is different from the states of consciousness such as waking, dreaming and deep sleep, as well as from the altered states of consciousness. In that sense it is regarded in Asian nondual philosophies as the consciousness-in- itself or, as the nature of consciousness.

Nondual Awareness

In this section I will research further the topic of nondual awareness, and in particular the objections to the existence of nondual awareness and to the similarity of nondual awareness and space.

Arguments Against Nondual Awareness in Tibetan Buddhism.

A number of traditions within Buddhism hold that one's cognitions, emotions and perceptions must stop in order to realize pure consciousness (Cozort, 1986). Another view is that this rule applies only to the earlier stages of one's meditation practice, and that after clearly realizing pure consciousness, one begins to integrate it with daily experiences (Kongtrul, 1996). However, since

nondual awareness, by definition, encompasses all experiences, including all states and functions of consciousness, it seems logical that it may not be necessary to first isolate it from experiencing in order to realize it. This becomes evident when one realizes that awareness is space-like and pervading throughout one's body and environment (Chagme, 1998).

The Dalai Lama summarizes this idea as follows:

> According to the more recent traditions of Tibetan Buddhism, …in order for this fundamental innate mind of clear light to become fully evident, it is necessary first of all for the coarser levels of ordinary mind, caught up with thoughts and concepts, to be harnessed by yogas, such as the yoga of vital energies, pranayoga, or the yoga of inner heat, tummo. On the basis of these yogic practices, and in the wake of those adventitious thought patterns of ordinary mind being harnessed and purified, the fundamental innate mind of clear light-'mind' in that sense-becomes fully evident.
>
> From the point of view of Dzogchen, the understanding is that the adventitious level of mind, which is caught up with concepts and thoughts, is by its very nature permeated by pure awareness. …the student experiences the nature that permeates them [concepts and thoughts] as the fundamental innate mind of clear light, expressing itself in all its nakedness. That is the principle by which practice proceeds on the path of Dzogchen (2004, p. 33).

Aside from the methodological arguments that question whether pure consciousness can be realized accurately within experience, Buddhist philosophers sometimes advance an argument against nondual awareness along these lines: If nondual awareness is the ultimate nature of consciousness outside of the cause-and-effect chain, then it is not empty in the sense of emptiness being the dependent arising, and this would contradict the central tenet of Buddhism that all things are empty of self-nature because they arise in dependence on causes and conditions (Dalai Lama, 2004). The answer given to this argument is that nondual awareness is permanent in the sense that its continuum is unbroken and endless, but since the present moment of nondual awareness arises from the previous moment of nondual awareness, it is also dependently arising. This answer satisfies the notion of the momentary-ness of consciousness, which is aimed at uprooting the tendency to reify nondual awareness into independently existing absolute. However, while this argument, preserves the nondual character of ultimate reality and of our experience of it, there is no way to deny that both pure consciousness and nondual awareness are unconditioned and unchanging, and in that sense could be called an absolute when compared to the transitory experiences. Thus, even though the holistic experience of reality is nondual in nature, there are still two distinct sides to it: the absolute and the relative. This argument then appears to be about two different things: how it is versus what it is. The answer to one is not the answer to the other, and this is a point of frequent confusion in Buddhism.

A more subtle argument against the existence of nondual awareness has to do with the nature of duality: If nondual awareness embraces all phenomena and functions of consciousness, as stated both in Dzogchen texts and in the Mahamudra notion of the "co-emergence" of awareness and experience (Namgyal, 2001), then what exactly constitutes nonduality? It cannot be a mere non-conceptuality as some Zen teachings claim. Transpersonal psychologists argue that duality is the result of the activation of defense mechanisms by which unwanted and threatening aspects of one's experience are blocked out (Almaas, 1996; Blackstone, 1997).

One can understand the nature of duality by examining the function of basic unconsciousness or alaya vijnana, which obscures self-recognition of awareness. The first characteristic of duality is that the awareness does not know itself directly. It is a dimming, so to speak, of awareness' brightness (Guenther, 1984). This dimming is followed by selecting an object, the foreground against the background, in such a way that the field of experience becomes fragmented into subject and object. Thus, duality is the result of basic ignorance (the failure of self-recognition) and the subsequent over-focusing which engenders excessive conceptualization (Trangu, 2002). Nondual awareness, on the other hand, differs from the ordinary dualistic mind in that it is without this division into subject and object (Sherab & Dongyal, 1998). In terms of cognitive psychology, it could be said that in nondual awareness the foreground and the background are seamlessly integrated.

Arguments Against Nondual Awareness as Space in Tibetan Buddhism.

Tibetan Buddhists sometime advance an argument against nondual awareness being like space as follows: Space is an object of experience, something on which a subject who is meditating focuses, and therefore it is a conceptual construct indicative of the dualistic mode of knowing, rather than being the nondual awareness (Khartar Rinpoche, personal communication, February 16, 2005). In answering this argument one could say: It is true that ordinarily one experiences space in this dualistic manner, as an object of one's cognition that is outside and different from oneself. However, the space of nondual awareness is not an object or something separate from oneself. This space, undivided between the inside and outside of one's body, is identical with one's awareness and is, in fact, one's true self. This identity is realized when one "rests within the expanse of the central channel," as indicated by statements such as: "During meditative equipoise, every phenomenon is of equal taste in having the essential non-referentiality of suchness, since, to illustrate this with an example, the experience of these is completely equivalent to the experience of the center of open space" (Gyamtso, 2004, p. 157). While outside the scope of this dissertation, Tibetan Buddhism, (Guenther, 1976) and more recently Transpersonal Psychology (Blackstone, 1997), extensively explore the significance of the central channel with regard to the realization of nondual awareness.

A classic Dzogchen text "Self-liberation through Seeing with Naked Awareness" also rebuts the argument by describing nonduality or enlightenment

as the intrinsic awareness that realizes the space of phenomena (Sanks. *Dharmadhatu*) (Reynolds, 1989). The same text then goes a step further in underscoring the phenomenological identity of nondual awareness and space when it admonishes followers of the Mahamudra style of meditation not to fall into the error of separating awareness and space.

Nondual Awareness in Advaita Vedanta

Union of absolute and relative. Of all the modern scholars and commentators on the classical Upanishads, Radhakrishnan (1995) addresses the issue of nondual awareness most clearly. He arrives at the idea of the union of absolute and relative, of pure consciousness and phenomenal experience, which he sees as simultaneous transcendence and immanence, through the reconciliation of the impersonal, absolutistic nonduality of Shankara with the theistic qualified monism of Ramanuja. He finds the roots of this idea in the Rg Veda's hymn of creation, which he believes suggests the distinction between Brahman and Ishvara, the universal pure consciousness and the cosmic creative mind (Radhakrishnan, 1995). In his approach, there are influences of both Sri Aurobindo's evolution of consciousness philosophy (Aurobindo, 1996) and attempts to validate Vedanta by finding similarities in it with Christianity, as when Radhakrishnan labels Brahman as "Godhead" – using Meister Eckhart's term.

Because there is an ongoing emphasis in Upanishad philosophy on both ultimate reality being transcendent absolute pure consciousness which is different from all phenomena, and on ultimate reality being identical with everything that exists, these apparent discrepancies have been a source of confusion and discord over many centuries. Radhakrishnan resolves this central issue by resorting to an intensely theistic interpretation. He reformulates the fourfold structure of the Universe and human experience found in the Mandukya Upanishad as: *Brahman*—the Absolute; *Ishvara*—God as Creative Power; *Hiranyagarbha*—God immanent in the World, or Word-Spirit; and *Viraj*— the material World. He states:

> The Eternal in his transcendent form as Brahman or, cosmic being as Ishvara, does not arrive at immortality. It is the individual who is subject to ignorance who rises to self-knowledge. The self-expression of the Supreme through the individuals will continue until it is completed. The Divine possesses always its unity, and Its aim in the cosmic process is to possess it in an infinite experience through many conscious selves. So long as we are subject to ignorance, we stand away from God and are immersed in our limited egos. When we rise to self-knowledge, we are taken up into the Divine being and become aware of the Infinite, Universal Consciousness in which we live. (Radhakrishnan, 1995, p.79)

Again we see here the influence of Aurobindo, as well as of Ramanuja's philosophy of qualified monism. Radhakrishnan states clearly that "we should see

all existence in Self and the Self in all existence" (1995, p. 130), yet he designates the relative in theistic terms. He does not accept that human life is an experience of impermanent, interdependent processes occurring against the background of pure consciousness. Rather he holds that there must be both a soul as an essential being integrating various processes and God that guides their unfolding.

The question here is whether his approach, and theism in general, is a result of personifying and reifying a state of consciousness, and whether in the long run this actually represents an obstacle to realizing the unity that is its goal. On the other hand, one may ask whether an impersonal approach constitutes a psychological depersonalization and dissociation. Radhakrishnan seems to understand clearly what realization of oneness or nonduality is, and that it has two different aspects to it – the absolute and the relative, whose relationship is the simultaneous transcendence and immanence. However, this view can also be understood differently. Since the nature of ultimate reality and the nondual realization that reveals it is entirely non-conceptual, the transcendent is not some other being different from oneself, even if that other is God. Rather, when abiding in nondual awareness, the same pure consciousness that one experiences as being transcendent to all phenomena is also experienced as being immanent in them. As such, it is entirely beyond mental grasping or labeling, as both Nagarjuna and Gaudapada point out.

This way of describing the realization of nondual awareness also follows the realization method laid out in the earliest Upanishads. First, one distinguishes pure consciousness from all other aspects of experiencing through the method of

negation (Sansk. neti, neti). Thereafter, the identity of pure consciousness, as Brahman or Atman, with all things is realized (Deutsch, 1973). It is from this position that we can best understand the seemingly contradictory statements, which on one hand distinguish Atman as different from all phenomena and, on the other hand, equate it with everything that exists.

The significance of simultaneous transcendence and immanence is that it implies that in order for one to directly realize or experience oneness or nonduality, pure consciousness must function as nondual awareness during phenomenal experiencing.

Now, one could argue that describing realization as simultaneous transcendence and immanence is indicative of duality, since for something to be either transcendent or immanent, there must be something else to which the entity is transcendent or immanent—thus, a duality. To answer this, one could say that all words like relative and absolute, and immanent and transcendent, are simply manners of speaking, and not to be confused with the reality they point to. Duality arises as the result of the reification of subject and object as being separate and essentially different. In the actual experience of realization, the two are inseparable and are of the same quality of being-awareness-bliss (Maharshi, 2000).

Arguments against nondual awareness as space in Advaita Vedanta. The most frequent objections to equating nondual awareness with space in Advaita Vedanta are based on strict vivartavada interpretation, according to which, as previously mentioned, pure consciousness is homogenous, atemporal, un-

localizable and cause-less, and cannot be realized as long as there is experience of any kind occurring (S. Atmaroopananda, personal communication, May 12, 2004). These objections find support in certain verses of the Upanishads, such this one from the Brihadaranyaka Upanishad: "This indemonstrable and constant being can be realized as one only. The Self is taintless, beyond space, unborn, great, and constant" (Radhakrishnan, 1995, p. 278).

Other objections concern the nature of space, seeing it as a mere negative or the absence of things, as in certain Buddhist doctrines. Shankara argues against this view in his commentaries on the Brahma Sutra of Badarayana (Vireshvarananda, 1993). The Brahma Sutra is a series of cryptic verses composed, according to traditional accounts, by Badarayana sometime in the fifth century B.C.E., as a mnemonic device for the Vedanta teachers in their arguments against the competing Indian philosophies of the time. It is likely, as with many other classical Vedanta texts, that a number of verses in the Brahma Sutra were added at some later point in time as debates over the specific viewpoints developed. The extreme brevity of the verses, which originally allowed for easier remembering and also protected their secrecy so that only those directly initiated could understand them, has in later centuries led to considerable challenges for their interpreters.

According to Shankara, the various metaphors for space mentioned in the Brahma Sutra refer to Brahman, the universal all-encompassing pure consciousness. For example, he says, "That which is called space is the revealer of all forms and names." Shankara claims that this verse describes Brahman

because it is preceded by the verse: "All this is Brahman" (Vireshvarananda, 1993, p. 47). Here, as in many of his interpretations, he stretches the implied meaning of the verses to justify his viewpoint. Yet, as often noted (Isayeva, 1993), Shankara achieves what is arguably the most elegant and coherent philosophical system of either East or West.

Darling (1987), who appears to have been a protégé of the late Alex Wayman, presents a careful exposition of how the major teachers of Vedanta (Shankara, Ramanuja and Madhava) misinterpreted Buddhism in their critiques of it. Of course, what he fails to mention is that the reverse is true as well. Among the verses of the Brahma Sutra that Darling selects for refutation is one of the sutras on space—that according to him reads: "And in case of space, because of non-distinction" (1987, p. 245). This sutra represents Badarayana's argument against the teachings of space being impermanent and a mere absence, found in the Sautrantika and Sarvastivada schools of early Buddhism. Shankara, Ramanuja and Madhava comment on this verse and disagree with Buddhists, advocating for the permanence of space and its identity with Brahman. While the formal logic of these arguments is not the present concern, it is important to note that Advaita Vedanta regards space itself, and the similarity of space and Brahman, as an ongoing permanent feature of ultimate reality.

Brooks (1968) also sees the difficulty with Vedanta's use of the idea of space, most obviously with the ambiguity of its translations, as mentioned before. More importantly though, Brooks revisits Shankara's argument against the notion that space is a mere absence:

> Indians made no real distinction between the concept of the very rarefied substance (ether) and a purely relational concept (space). Shankara, in fact, while arguing against the Buddhist realists, even claims that space (akasha) cannot be merely a negative thing (the absence of objects), for one has to be able to determine where this absence is—and that requires a positive determination, therefore a positive entity (1968, p. 36).

Here Brooks misunderstands the space referred to in the Brahma Sutra and in the Upanishads as being a conceptual level of space, the space that is cognized as an object, thus implying distance and a relationship. Rather, the use of space in these Vedantic sources indicates the realization of the sameness of space inside and outside, as an all-pervading nondual awareness. The translation of space as ether is an unfortunate anachronism and a mistake, as noted before.

Interestingly, just a few pages later, Brooks arrives at the simultaneous transcendence and immanence of pure consciousness, by examining the metaphysical dimension of space:

> In the final analysis, then, all material objects, including the vehicles of human consciousness, are composed of akasha *(space)*. It must be emphasized, however, that akasha *(space)* itself doesn't alter its basic nature in the process. All that occurs is its molding into differing forms which are given different names (1968, p. 38).

From a larger perspective, one could say that the emphasis on the existence of space in Vedanta, or on the lack of its inherent existence in Buddhism, is only a matter of pedagogical approach. There is no difference in the experience of the actual space dimension of nondual awareness that can be realized through either of these traditions.

Summary

The conclusion of the above research is that nondual awareness is pure consciousness occurring with experience, and that it is the space-like context of experiencing. The next section of this chapter will examine what are the neural correlates of nondual awareness, and whether the neural correlates of space in the posterior parietal cortex mediate nondual awareness in conjunction with areas in the pre-frontal cortex.

Neural Correlates of Pure Consciousness and Nondual Awareness

This section presents the research on the question: "Do the neural correlates of space in the posterior parietal cortex meditate nondual awareness, in conjunction with medial and dorso-lateral areas of the pre-frontal cortex?"

As mentioned in the introduction, the significance of modern scientific research on meditation is that it can facilitate the overall goal of neuroscience to find the neural correlate of consciousness. It can also prove certain theories of Asian nondual philosophies, which have been contentious for centuries – through more or less unambiguous brain measurements.

However a question can be raised whether pure consciousness and nondual awareness described in the Asian philosophies are the same as those that are being tested by the scientists. In defining the difference between lucidity and witnessing during dreaming, Travis (2003) states that in witnessing, there is a quality of a steady separate self who is silently observing but not influencing the dream, whereas during lucid dreaming, the subject feels involved in the dream and does not experience himself as separate. He sees this as a sign of meta-cognition during lucid dreaming and points to studies by Gackenbach (1985) that showed that lucid dreamers have a higher capacity for observing their daily experiences, as well. It is important to note, however, that pure consciousness is not meta-cognition, because it is not a conceptual process of thinking about something or even reflecting on the process of thinking. Rather, it is consciousness resting in its own nature.

Wallace (2004) argues against the claim of TM researchers that their subjects experience pure consciousness. In accordance with the Yogachara philosophy of Buddhism, he claims that the presence of substrate consciousness, which underlies discrete states of consciousness, is not yet the evidence of pure consciousness. According to him, the substrate (Sansk. Alayavijnana) functions as the indeterminate background from which either the dualistic or pure consciousness emerges. The difference can be ascribed to the degree of non-conceptuality. However, there can be a complete mental quiescence without self-recognition of consciousness. Wallace (2004) claims that encountering pure consciousness, as when one attains lucidity during deep sleep without experiencing anything but awareness and the awareness is recognized, is not yet pure consciousness because this recognition is a conceptual activity, as in: "I am now aware." Conversely, pure consciousness is self-knowing and does not require a thought process. This direct knowing is then manifested as an extra luminosity and a vividness of awareness.

However, the matter is a bit more subtle, because pure consciousness can also occur in the presence of other functions of mind, such as thoughts, so that one can be in pure consciousness and simultaneously think: "I am aware." The proof that TM subjects are realizing pure consciousness, and not just the substrate, are the alpha-theta wave bursts. For his part, Travis does not make the distinction as to whether pure consciousness is self-recognized or not.

D'Aquili & Newberg (1999, 2002) appear to conflate pure consciousness with nondual awareness. They describe the loss of "all sense of discrete being"

and the remaining “undifferentiated consciousness”. These are descriptions of the states of absorption and isolation of consciousness from experiencing. However, the question remains as to whether these states indicate that pure consciousness has become self-recognized, or whether these are various states of absorption experienced on the way to realizing pure consciousness – for the descriptions could easily refer to the states of energetic merging that frequently occur during meditation, but which are not the realization of either pure consciousness or nondual awareness. As pointed out earlier, nondual awareness is not a state of disorientation and loss of psychological boundaries. Rather, nondual awareness does not fragment the field of experience into subject and object.

Brain at Rest

As mentioned previously in the methodology section, one of the central issues is the neural activity of the brain at rest. Because the brain at rest generates noise in fMRI scans, it may not be entirely appropriate to attribute all of the activations obtained in fMRI meditation studies to meditative states of consciousness such as nondual awareness. Others have noticed this problem for some time (Zarahn, Aguirre & D’Esposito, 1997), and so patterns of brain activity at rest are now being examined using different methods of data analysis (Fransson, 2004).

One could logically assume that the brain at rest shows decreased activity across all areas, since when one is resting, the brain seems to be less active, if not inactive. Surprisingly, Reichle, MacLeod, Snyder et al. (2001) found a pattern of

continuous higher activation in certain brain areas when at rest than when the brain is performing a task. This suggests "...the existence of an organized, baseline default mode of brain function that is suspended during specific goal-directed behaviors" (Raichle et al., 2001, p. 676). The areas of higher activation are chiefly the posterior cingulate gyrus and its connections to prefrontal areas. In addition, the researchers state that the high activity in the medial frontal and medial parietal regions represents the unified perspective of the organism relative to its environment, and thus is a constituent of a self. This brings into question whether such activations are found during nondual awareness, since, as shown in a previous literature review section, some main features of nondual awareness are deactivation of focused task-oriented attention and the lack of fragmentation of experience between the self and the environment.

Gusnard, Abdulkak, Shulman et al. (2001), found that the dorsal medial prefrontal cortex shows increased activity during the rest state consistent with self-referential mental activity, while decrease in the activity of the ventral medial prefrontal correlates with attention-demanding tasks related to processing emotions. They conclude that the default state of the brain at rest consists of both self-referential and emotional processing activity subserved by the medial prefrontal cortex. This finding may be relevant to the study of nondual awareness, which as discussed before, is a way of resting in being.

Laufs, Krakow, Sterzer et al. (2003), found oscillations in the alpha range which they correlate with inattention during the rest state, and oscillations in the

beta range which they believe correlate with spontaneous cognitive operations during conscious rest.

Finally, Fransson (2004), contends that there are actually two networks that operate when the brain is at rest: one that is self-referential and consists of the medial prefrontal cortex and posterior parietal cortex, and another that is involved in monitoring external space and extroverted processes and possibly consists of areas in the somatosensory, motor, and visual extrastriatal areas, the insula, and the parietal and lateral prefrontal cortexes. These two networks are mutually exclusive and alternate between each other. Fransson hypothesizes that this alternating between the two is the state of the brain at rest. A new study by Raichle and colleagues appears to confirm this (Fox et al., 2005).

Building on the above-mentioned studies of the resting state of consciousness, Lou and colleagues (2004) propose that the medial parietal cortex is the seat of the autobiographical self, and that this area is activated with the medial prefrontal cortex and posterior cingulate gyrus during the brain at rest, because the resting state is a self-monitoring process involving autobiographical self and episodic memory.

As mentioned previously, in nondual meditation, one realizes internal and external space to be the one and the same space. This implies that there is no necessity to shift between self-referential and external-centered processing. This important point will be further explored in the next section.

As previously pointed out in the methodology section, the problem with using the resting state as a control state, against which activations during nondual awareness are measured, is that the resting brain state of someone who has years of meditation experience is quite different from the resting brain state of a "normal" individual. Meditation leads to an overall decrease in metabolic rate and a general decrease in conceptual activity of the mind, and specifically, to a decrease in self-preoccupations—in other words, to a decrease of thinking related to the biographical self. The question that arises here, relevant to the study of nondual awareness, is whether these areas should be de-afferented during nondual awareness, since one is not centered or abiding in the biographical self.

When a meditator experienced in meditation on nondual awareness rests, that is, when he or she is not meditating and is thus presumably not in nondual awareness, one could speculate that she or he is abiding in alaya vijnana or the substrate consciousness (Wallace, 2004). Thus, there is not much conceptual or emotional activity occurring in his brain. From there, the shift to nondual awareness is a very small shift into awareness knowing itself directly.

The nature of the brain at rest is a considerable issue for research into neural correlates of nondual awareness, because nondual awareness once realized cannot be unrealized, so that even when the realized meditator is resting, there is some background signature of realization present. In an unpublished study conducted at Rutgers University using an experienced meditator, there was an overall decrease in BOLD signal responsiveness, even during eyes-open tasks. This is to be expected because one trains to rest in nondual awareness in such a

way that nondual awareness becomes one's ongoing background state of consciousness.

Neural Correlates of Pure Consciousness

Since in the previous section of the analysis it has been determined that nondual awareness is pure consciousness operating with experience, in order to research whether the neural correlates of space mediate nondual awareness, the neural correlates of pure consciousness will be examined first, and then the neural correlates of nondual awareness and of the space in meditation.

Recognizing pure consciousness as a valid topic of research in the field of neuroscience has been a difficult and relatively recent development (Varela & Shear, 2002). Progress on this issue is hampered by the general orientation of Western philosophy and science toward relativism and functionalism, and, as mentioned previously, by the excessive focus on the contents of consciousness (Shear & Jevning, 1997; Taylor, 2002, 2003). Research into pure consciousness is also made more challenging by the difficulty of accurately understanding what pure consciousness is. For example, Taylor correctly differentiates pure consciousness from the contents of consciousness, yet draws a conclusion that pure consciousness is a state where attention is attending to itself (2002). As noted earlier in the section on Vedanta, attention too is a function of consciousness, not consciousness itself.

As mentioned in the review of literature, EEG studies of meditation focus on several characteristics of the general meditative state of consciousness: the

increase in alpha waves associated with relaxation; the strong frontal bursts of theta waves associated with peaceful self-awareness; bursts of high frequency beta and gamma waves in the 20-40 Hz range associated with intense concentration or periods of ecstasy; the de-coupling of subcortical structures from the cortex; and hemispheric synchronization - a coherence of brain waves across the left-right and anterior-posterior areas of the brain (Murphy & Donovan, 1999). The sequential progression of EEG changes during the course of a meditation session have been summarized as follows: Initially, there is an increase in alpha amplitude posteriorly, and then there is a slowing of alpha frequencies and a forward spread into frontal areas. This is followed by an increase in theta activity in the range of 6-7 Hz, first in intermittent bursts and then with increasing regularity until rhythmic theta trains become synchronized in both anterior and posterior EEG leads. Then, in deep meditation, bursts of high beta waves appear in the range of 20 Hz and above (Andresen, 2000).

To better appreciate what might be occurring in meditating brain in terms of electrical activity detectable by EEG, especially as it relates to pure consciousness and to nondual awareness, it is necessary to discuss a few background facts regarding the neuronal binding and synchrony.

Neuronal Binding and Synchrony

One of the main issues in neuroscience is the problem of "binding" – that is, how to explain the fact that the brain organizes a great deal of disparate information into a coherent experience. For example, when I see my wife in her

car pulling into our driveway, the shape of the car, its color, its movement, the sound of the engine and my wife's face are all coded in different parts of my brain, yet I have one unified experience. This issue is even more pronounced in nondual awareness, which is characterized by the extraordinary coherence and unity of experience. Engel & Singer (2001b) summarize the issue of binding:

> 1. Consciousness results from a cooperative process in a highly distributed network, and is not attributable to a single brain structure; 2. binding is highly relevant for the neural correlate of consciousness; 3. only coherent activity, resulting from the operation of binding mechanism, could become functionally salient, causally efficacious and globally available, and, thus could lead to the emergence of conscious mental states and their respective behavioral manifestations. The critical point is that binding may not only serve for achieving the 'unity consciousness' but, first of all, for 'gating' the access to awareness and, hence, for turning subconscious information into conscious mental content (pp. 21-22).

How is this binding accomplished in the brain? The serial transmission of signals from neuron to neuron through axonal firing is far too slow to account for this unity of experience. The mechanism proposed is neuronal synchrony, the temporary synchronization of neuronal discharges. Some postulate that all cognitive processes in the brain, such as perception, emotion, action, attention, imagination, abstract thinking, and others, depend on the coordination of widely distributed neural networks – producing a temporarily unified global brain activity

– and that their integration is neuronal synchrony, the firing of distant neurons at the same frequency (Engel et al., 2001a&b; Llinas, Ribary, Contreras & Pedroarena, 1998; Varela et al., 2001). Synchronized firing is then a time-sensitive code that links neural representations so that they can form a unified experience, such as for an object one is seeing. Treissman believes that "…attention limits might reflect limits on the number of different synchronies that can be maintained at one time, and illusory conjunctions might reflect accidental synchronies that result when too many objects are coded at once" (Gazzaniga, 2002, p. 167).

However, the synchrony that supports more complex states of consciousness must differ in several respects; most importantly, it is a large-scale coherence involving different modalities (Engel & Singer, 2001b). This type of synchrony is not equivalent to the uniform global synchrony that occurs in deep sleep and in episodes of epilepsy, which is counterproductive to consciousness (Engel & Singer, 2001b). More complex states of consciousness have been explained by postulating higher order contexts, which bind contents into progressively more complex patterns through interactions in different frequency bands. "Such higher order binding could form the basis for 'meta-representations' necessary to incorporate low-level contents into global world-and-self-models" (Engel & Singer, 2001b, p. 24).

For this present study of pure consciousness and nondual awareness, it is important to note that the coherence that might be mediating elaborate conceptual thought patterns is likely not the same kind of coherence as the one mediating

pure consciousness and-or nondual awareness, because it is precisely the conceptual "world-and-self-models" that become relaxed during meditation. Thus, it is possible to have a global synchrony with a synchronous and stable alpha, theta or even delta wave frequency with eyes open, which constitutes a higher form of consciousness than that of sensory awareness or world-self concepts. As seen in preceding sections, how these two more basic levels of conscious experience become integrated with nondual awareness is known as co-emergence in the Mahamudra tradition of Tibetan Buddhism and as parinamavada in the Advaita Vedanta philosophy of Hinduism.

In hypothesizing about the nature of binding, which produces a unified sense of consciousness, Austin (2000) refers to brain wave synchrony research by Parthasarathy, who claims that mental coherence arises when peaks of gamma waves in 40 Hz frequency and theta waves in 7 Hz frequency settle into phase relationships. Zohar and Marshall (2000) see synchronous neural oscillations in the 40 Hz range as the neural basis of higher-order unitive intelligence, which they call "spiritual intelligence." In their model, synchrony is not only above the threshold of axonal firing of neurons, but also in the sub-threshold range among dentrite-to-dentrite connections that create a quantum field effect.

Possibly the most significant anatomical units for the generation of synchrony are the re-entrant thalamocortical loops (Edelman, 2004; Llinas et al., 1998). These neural circuits form either non-specific loops or specific sensory loops. Non-specific loops provide the context of experience, such as alertness, and the sensory loops provide the content (Llinas et al., 1998). A non-specific

loop is the thalamic intralaminar input to layer I of the cortex and its return pathway which projects via the layer V and VI pyramidal cells to the intralaminar nuclei of the thalamus. Re-entry is along the same pathway, in addition to the connection to the reticular nucleus of the thalamus. The specific thalamocortical neurons, cortical layer IV, and the local inhibitory interneurons form the sensory loop. Re-entry of the specific loop into the thalamus is through the layer VI pyramidal cells, which can connect to the reticular nucleus of the thalamus and the corresponding specific thalamic nuclei (Llinas et al., 1998).

However, neither of these two classes of loops can generate consciousness alone. Rather, they work together to create conscious cognition. They do this by oscillating in synchrony at 40 Hz frequencies (Llinas et al., 1998). The primary role of the majority of thalamo-cortical loops is not relaying sensory stimuli. Rather, they form the feedback circuits through which neurons self-organize into globally distributed 40 Hz gamma waves. This allows for temporal binding and the functioning of conscious mind (Zohar and Marshall, 2000)

Llinas et al. conclude that "...rather than a gate into the brain, the thalamus represents a hub from which any site in the cortex can communicate with any other such site or sites" (1998, p. 1), and that therefore, "consciousness is not a byproduct of sensory inputs but rather is generated intrinsically and is modulated (or contextualized) by sensory inputs" (Zohar & Marshall, 2000, p. 76).

This complexity of thalamocortical loops indicates that the brain evolves and develops not only bottom-up, from older and more primitive structures

toward the neo-cortex, but that there is also an ongoing change in the function, and even anatomy, of the lower brain centers due to their re-integration instituted by the neo-cortex. Judging by the change in the quality of awareness produced by meditative "centering," that is, by placing attention centrally within the body and brain, it is likely that the functions of the thalamus, which is so profoundly integrated with the cortex, are more complex than we realize.

Biofeedback studies using EEG, known as neuro-feedback, offer a possible model for EEG patterns of integration of pure consciousness with daily experience. Brown (2001) describes his five-phase model of treatment as: Phase I is the suppression of "bad" theta in the 3-5 Hz range and the stabilizing of beta in the 14 Hz range. Phase II works to augment beta waves – first in the low range of 15-18 Hz, and then in the high range of 20+ Hz. This augmentation is associated with focused attention and enhanced capacity for cognitive processing. Phase III is dedicated to enhancing alpha waves and achieving "the relaxation response." Phase IV is the protocol developed by Peninston (1990) where a surge in theta activity occurs simultaneously with stable and enhanced alpha waves to create alpha-theta coherence. While the cortically originating 3-5 Hz theta activity is seen as undesirable, thalamically originating theta in the range of 7 Hz is considered beneficial. Phase V constitutes a proliferation of global synchrony (EEG activity that is coherent across distant regions of the central nervous system), and this is associated with the state of creative tranquility (Brown, 2001). Brown describes the process and effects of synchrony as follows:

> Synchrony usually occurs first in the Alpha band, with progression down into upper regions of Theta and ultimately down into the lower regions of Theta, and even into what has been traditionally referred to as Delta (viz. 2 to 4 Hz). It is interesting to notice the change in the client's physiognomy and symptomatology as Synchrony is achieved and sustained, especially in the lower Theta and Delta range. The result is particularly striking for the immune system involved individuals, who report experiencing a sense of lightness and joy which has been absent for years, if they can even remember it ever being present in their lives. Ultimately, it is most transformative for Synchrony to be achieved through the lowest Theta and Delta ranges with eyes open (Brown, 2001, pp. 10-11).

This description underscores the difference in brain functioning between normal subjects, where de-synchronized patterns predominate and synchronous oscillations are only transient, and those experienced in meditation, where global synchrony is evident and stable. The presence of an ongoing alpha coherence has been reported as the most universal distinguishing feature between meditators and non-meditating subjects (Andresen, 2000). The ubiquity of the alpha wave has led some to postulate that it is the chief overall signature of consciousness (Baars, 2004). The data on synchrony also points to the possibility that meditative awareness is a result of entrainment, rather than an inherent property of mind that becomes "uncovered" in the process of meditation, as held in the Asian contemplative traditions. It is also significant that a possible equivalent of nondual

awareness - synchrony in delta and theta range with eyes open – has been found to be the most transformative.

The findings of Davidson's group (Brefczynski-Lewis et al. 2005; Davidson, 2004b; Lutz et al. 2004) that the signature of meditative awareness is the appearance of large-scale fronto-parietal synchrony in the gamma spectrum, conflict with some of the TM studies mentioned previously, which found increases in the alpha-theta range. Travis' team found that long-term TM meditators report that their experience of pure consciousness co-exists with their waking and sleeping states, indicating the realization of nondual awareness. Change in the patterns of functioning of the frontal lobes, such as the forward spread of alpha waves into the frontal areas, is associated with an increased sense of the presence of a witnessing self during daily activity. The increase in frontal lobe EEG coherence suggests "greater functional co-ordination of the frontal circuits involved in the neuronal implementation of one's self-model" (Travis, Tecce, Arenander & Wallace, 2002, p. 311). An increase in coherence of 6-12 Hz frequencies in the frontal, central and parietal areas was found during eyes-open tasks. Travis primarily regards the experience of pure consciousness functioning in daily experience to be this type of alpha-theta coherence, and he finds the simultaneous presence of coherence in beta and gamma bands to indicate integration with cognitive activity.

Davidson's group, however, attributes these differences in brain wave frequencies to different styles of meditation: Meditations such as the mantra

repetition meditation used in TM involve concentrated focusing of attention, which emphasizes top-down processing with the resultant slowing down of brain oscillations. In contrast, objectless meditations cultivate specific states of being, during which focusing of attention on objects is allowed to dissipate. "The dissipation of focus on a particular object is achieved by letting the very essence of the meditation that is practiced (on compassion in this case) become the sole content of the experience, without focusing on a particular object" (Lutz et al., 2004a, p.16372).

The findings of the EEG studies of pure consciousness and nondual awareness can be summarized as follows: the EEG signature of pure consciousness is the forward spread of alpha waves and the appearance of rhythmic theta trains, while the EEG signature of nondual awareness is synchrony in the gamma range occurring possible with the presence of delta waves even with eyes open. These studies indicate that nondual awareness is a state of large-scale neuronal synchrony involving both the inter-hemispheric synchrony and the fronto-parietal synchrony, and that it can function as a context for sensory, affective and cognitive processes.

The following section examines whether the neural correlates of space in the posterior parietal cortex are involved in mediating nondual awareness.

Nondual Awareness and Space

In order to provide a context for examining the possible role of the neural substrates of space in nondual awareness, this section begins with a brief theoretical background of the functions of the parietal lobes and hippocampus in the experience of space. In addition, to facilitate the discussion in this section and the later discussion of the findings and conclusions of present research, a set of fMRI data of a single subject study of nondual awareness is included in the Appendix. This scan is a part of the larger study of the neural correlates of nondual awareness that I am conducting presently at the Rutgers University, NJ. This data is used here as an illustration only, and does not constitute the main body of research.

The parietal lobes of the brain are the areas of the cortex bounded by the central sulcus, the parieto-occipital sulcus and the Sylvian fissure. The parietal lobe's anterior area consists of the postcentral gyrus (BA 1, 2, 3) and the parietal operculum (BA 43). The parietal lobe's posterior area is divided into a superior region (BA 5, 7) and an inferior region, which consists of the angular gyrus (BA 39) and the supramarginal gyrus (BA 40) (Burgess, Jeffrey & O'Keefe, 1999). According to current understanding, the "parietal lobe acts as a true sensorimotor interface contributing to the sensory guidance of movement and to perception of space by offering non-sensory, mental representations of space suited to the needs of the specific task" (Thier & Karnath, 1997, p. 11).

Of particular interest to the present study is the function of area BA 7, which includes the posterior superior parietal lobule and parts of the precuneus. This area is the terminating point of the dorsal "where" pathway (Milner & Goodale, 1995; Ungerleider & Mishkin, 1982), which is involved in processing spatial location, as well as other spatially related functions such as geometric features, egocentric framework, and visual-spatial attention and transformations (Thier & Karnath, 1997). In addition, "the loss of spatial memories after lesion of the posterior parietal cortex suggests that these memories are laid down there, with the aid of the hippocampus" (Anderson, 1999, p. 90).

The inferior parietal lobule, on the other hand, is responsible for awareness of the contralateral space, the higher order synthesis of various sense perceptions, and is involved in the ventral "what" pathway. Karnath (1999) suggests that spatial explorations and orienting in space are subserved by the neural representation of egocentric space in the inferior parietal lobule, while the visual-motor spatial processes are subserved by the neural correlates in the superior parietal lobule.

In their classic study, Ungerleider and Mishkin (1982) found two different neural pathways for processing visual input in higher order visual areas: the dorsal "where" pathway from the occipital to the superior posterior parietal cortex for processing spatial relations, and the ventral "what" pathway from the occipital cortex to the inferior temporal gyrus for processing object properties. While a number of lesion studies further confirm this basic organization (Farah, Hammond, Levine et al. 1988; Levine, Warah & Farah, 1985), there are also

differing views. For example, Ramachandran (1998) [, after Goodale,] regards the dorsal pathway as the functionally "how" pathway, because of its involvement in sensorimotor control. Furthermore, Milner & Goodale (1995) believe that the ventral stream is also involved in spatial processing, albeit of a different kind. According to them, the ventral pathway mediates conscious perception of the world, and conscious perception of the allocentric spatial layout, while dorsal pathway spatial processing has more to do with navigation and egocentric coordinates of the location of objects in relation to the observer. Zacks and colleagues (1999) find the "how" pathway to be subserved by the left parietal-temporal-occipital junction area, and the "where" pathway subserved by the right posterior parietal area. Earlier studies of allocentric-egocentric spatial processing focus on the function of the medullary lamina of the thalamus and the posterior hippocampus, and they report that these structures operate like a global positioning system (Austin, 1998).

In addition to the parietal lobes, the hippocampus, a limbic structure enfolded deep within each temporal lobe, also plays a central role in the experience of space, in particular in spatial memory, such as the memory for topographic layouts of landmarks and for spatial arrays of objects. The hippocampus also facilitates the allocentric spatial frameworks (Burgess et al. 1999). Most agree that the hippocampal place cells enable these types of spatial memories (Rothenberg & Muller, 1999). Two distinct mechanisms participate in this process: "one dependent on environmental features (referred to as

exteroceptive) and the other dependent on proprioceptive and vestibular cues (referred to as idiothetic)" (Burgess et al., 1999, p.183).

Evidence from existing research indicates that the brain constructs a number of different spatial representations. This contrasts with subjective experience, which informs us that we have a single spatial map of our environment in which objects and actions are represented in a unified way. Instead, the brain constructs not one space, but many spaces, continuously adjusting egocentric and allocentric spatial reference frames (Colby, 1999). Anderson (1999) summarizes this view:

> The posterior parietal cortex combines signals from many different modalities to create an abstract representation of space. The modalities involved include vision, audition, and somatosensation (neck proprioception), as well as signals derived from the vestibular apparatus and signals indicating eye position and eye velocity....It is possible that humans' unitary impression of space, independent of sensory modality, may be embodied in this abstract and distributed representation of space in the posterior parietal cortex. (p. 101)

It is this unitary sense of space that becomes deepened and refined in the realization of nondual awareness. While the brain operates at a certain level by creating different spatial maps, from the perspective of nondual awareness, one could ask whether spatial representation becomes even more of a unitary event in nondual awareness, occurring as higher order coherence and synchrony sets in –

for not only is there sameness of space inside and outside in nondual awareness, but also in the practice of such meditation, there is a progressive decrease of the fragmentation of subjective space in general. If nondual awareness is latent and underlying all other states and functions even when not actualized, as Asian nondual philosophies claim, this implies that such unitary spatial representation exists somehow as a latent potential in the brain.

Although there is the previously reviewed research on pure consciousness that addresses the loss of the sense of space that occurs in meditative absorption (D'Aquili & Newberg, 1999, 2002; Newberg, 2000; Newberg et al. 2001; Travis et al., 2002), no one has yet researched neural correlates of space in nondual awareness. Austin (1998), however, does address the issue of the experience of space in meditation. Austin's speculation, that allocentric areas of the brain are responsible for the sense of unity during meditation—while at the same time, functioning of the egocentric areas is stopped, is relevant for my hypothesis that the neural correlates of space mediate nondual awareness. However, it is an oversimplification to see this as a choice between an egocentric and allocentric frame of reference. Nondual awareness pervades equally throughout space both inside and outside oneself. Thus, it is important not that the space as a conceptual experience need to be researched, nor the allocentric space as opposed to egocentric, but that the neural correlate of the sameness of the space inside and outside needs to be found.

Of particular interest to the present research are Austin's findings regarding space in the experience of meditation. Austin distinguishes three different levels of awareness in relation to the experience of space. This researcher quotes his table as follows:

> a) *unconscious circumspatial awareness,* the automatic sense of space normally surrounding the person, a hidden polysensory integration of space which we access in our usual daily activities; b) *ambient vision,* an automatic surge such as in internal absorption, vast unbounded space, the experience of circumspatial awareness in rare states of heightened consciousness; *c) comprehensive vision,* a brief automatic surge in kensho, space in front infused with coherent insight-wisdom, syncretism, the direct experience of all things as they really are in the absence of the personal self (Austin, 1998, p. 495).

This researcher agrees with Austin that these three levels of the experience of space in meditation exist; however, none of them represents the space of nondual awareness. First of all, the ordinary daily experience of space, which he describes as being related to the unconscious circumspatial awareness, is actually a highly edited version of the space of nondual awareness. However, it is filtered unconsciously through the "I-Me-Mine" personality structure, and also through one's entire unconscious self-world map.

Second, the ambient vision is one of the numerous unusual experiences of space that may accompany altered states of consciousness, that one commonly

and floods the brain. It too is a derivative of the space of nondual awareness, only now cognized with an altered state of consciousness. Austin speculates that the stimulation of the reticular formation in the midbrain may cause the cells in the "lateral geniculate nucleus to expand the size of the visually receptive fields…" (Austin, 1998, p. 497). He postulates another possible mechanism, which involves the secondary visual system consisting of the superior colliculus, pulvinar, and posterior parietal lobe. This system is responsible for "reflexive visual responses in relation to orientations in space" (ibid, p. 497). Austin also hypothesizes that increasing the release of norepinephrine could lead to the expansion of one's internal visual field. Thus, the ambient vision, for him, is primarily an internal visual experience of space. However, the ambient vision can occur even with the eyes wide open, so that one is temporarily able to perceive objects outside of the range of one's normal visual field (Josipovic, 1998).

Third, Austin's characterization of the "comprehensive vision" occurring during insight-wisdom experience is based on the predominant activation of the frontal lobes in a surprise stimulus ("What to do about this?") and the predominant activation of the parietal lobes in a habituated stimulus ("There it is"). He postulates that during a moment of insight-wisdom that is triggered by an unexpected stimulus while the meditator is absorbed in a heightened awareness, there will be a "major fronto-parietal response" (Austin, 1998, p. 286).

With respect to the experience of space, Austin appears to hold that kensho-related space is the final level of the awareness of space. The spaciousness that is integral to nondual awareness is, however, of a different and higher order.

Using his mapping of the stages of awareness and the corresponding experiences of space, this researcher holds that the space of nondual awareness is the space of pure being, which indicates stability of realization beyond the episodes of kensho-insight. Thus, a fourth category of awareness is added to the Austin's three:

d) *nondual awareness*, an ongoing deepening realization in which the space that pervades everywhere is the sameness of space inside and outside of oneself, and one realizes oneself to be the all-encompassing being-awareness-bliss.

The scans from the data sample presented in the Appendix, support this conclusion. They show, among other results, activations in the left posterior superior parietal cortex (BA7), which is related to the experience of space from one's own perspective; in the dorso-lateral pre-frontal cortex (BA 46, 45), related to integrating the spatial dimension and mediating the bliss and compassion dimensions of nondual awareness; in the ventro-medial pre-frontal cortex (BA 9, 10) related to direct non-conceptual experiencing.

Analysis Summary

The research question this study asked was: " Do the neural correlates of space in the posterior parietal cortex mediate nondual awareness, in conjunction with the medial and dorso-lateral areas of the pre-frontal cortex?" While a number of limitations were found to exist, most significantly the scanner noise and the nature of the fMRI signal in the brain-at-rest, the answer that emerged is that neural correlates of space in the posterior parietal cortex mediate nondual awareness in large-scale fronto-parietal synchrony with the medial and dorso-lateral areas of the prefrontal cortex.

Furthermore, the space of nondual awareness is not space as a perceptual or as a conceptual experience, nor the allocentric spatial perspective as opposed to the egocentric one, but a deeper unified space of the sameness of inside and outside. It is this unitary sense of space, which is the context of all phenomenal experiencing (Sansk. Dharmadhatu), that is the space of nondual awareness.

If nondual awareness is the latent nature of consciousness, which underlies all states and functions of consciousness even when not actualized, as held in the Asian nondual philosophies examined here, this may imply that the representation of such unitary space may also exist as a latent potential in the brain. Whether implicit or explicit, such representation is necessarily located in the posterior parietal cortex.

However, nondual awareness is not limited to its spatial dimension, and thus to the functioning of the posterior parietal lobes. Its self-knowing is reflected

in the simultaneous functioning of the pre-frontal cortex. In addition, nondual awareness has a luminosity dimension that is its clear light, a bliss dimension that is the basis of love and compassion; and according to the Advaita Vedanta tradition, a dimension of self-identity. Thus the neural correlates of nondual awareness are complex, involving in addition to the frontal and parietal areas, possibly: the occipital areas for luminosity, the limbic and basal forebrain areas for processing emotions, and the medial frontal and parietal areas involved in maintaining a sense of self-identity. The data sample presented in the Appendix shows activations in the posterior parietal cortex, the dorso-lateral and medial prefrontal cortex, the anterior cingulate, and the occipital cortex, consistent with this hypothesis.

In nondual awareness, the sharp difference between the stillness and emptiness of pure consciousness, on one hand, and the ceaseless unfolding of ordinary experiences, on the other, disappears and both become seamlessly integrated into oneness. This then supports the idea that nondual awareness is not the result of merely a deafferentation of certain areas in the brain, as in absorption, but of a synchrony that serves as a context and optimization of all of the brain's functions.

CHAPTER SIX: DISCUSSION

This chapter will offer an integrated theoretical model, and reflect on the meaning of the present study in the context of the relevant literature. The research conducted indicates that the neural correlates of space in the posterior parietal cortex mediate nondual awareness in synchrony with areas in the medial and dorso-lateral pre-frontal cortex. Nondual awareness is pure consciousness functioning with experience as space-like context that, phenomenologically, pervades the field of experience inside and outside of oneself.

From the analysis in the previous section, it is evident that during the experience of pure consciousness, there is an absence of perceptions, thoughts, space and time, and the sense of personal self, due to withdrawing of attention during meditation, and shutting down of the functions associated with the corresponding areas of the cortex. Thus, the best way of approaching the understanding of the neural correlates of pure consciousness is through the examination of occurrences of being awake within the deep sleep, since the absorption meditations, which lead to the pure consciousness, essentially mimic this event. When one awakes within the deep sleep a number of significant features can been noticed, such as: the complete absence of light or any other sensory stimuli; there is no sense of direction, no up or down; there is no sense of body; there is no sense of space or time; there are no images or words present; and there is no sense of one's personal autobiographic self. Yet, there is

consciousness, a pure self-knowing consciousness, not different from oneself. Since the chief characteristics of the deep sleep is the predominance of cortically originating delta waves, as the cortex becomes freed from the activating influence of the brainstem's reticular formation and the thalamus, the neural correlates of pure consciousness are most likely in the cortex itself. The absence of the sense of body and the other above-mentioned features indicates that the occipital, parietal and temporal lobes are relatively inactive as well. Therefore, the pre-frontal cortex is the most likely site of the neural correlates of pure consciousness.

Furthermore, the key characteristic of pure consciousness, that it is self-knowing, leads to the question of how the brain functioning during an event of pure consciousness within the deep sleep, differs from the brain functioning during the ordinary deep sleep? The only research conducted so far on the occurrence of pure consciousness during seep sleep (Mason, Alexander, Travis et al. 1997) found an increase in the alpha-theta activity, occurring over the delta waves that characterize deep sleep. This implies that there is some, however subtle, activation of sub-cortical structures, in particular the thalamus and possibly the anterior cingulate cortex, since alpha waves are generally believed to be thalamocortically originated. The fact that the activity in the intralaminar nucleus of thalamus is necessary for consciousness to manifest is also an indication of the thalamic involvement. It is possible that activations of the basal ganglia and other subcortical regions postulated in the TM model could be due to maintaining, however unconsciously, the upright cross-legged position during TM meditation, and are not directly involved in mediating pure consciousness.

Finally, the question arises, where in the prefrontal cortex is the neural correlate of pure consciousness? Due to the constraints of the equipment, fMRI studies of pure consciousness, which can answer this question, have not been done. Newberg's research using SPECT tests indicates the activity of dorso-lateral areas of prefrontal cortex in inhibiting the posterior parietal lobes. The dorso-lateral PFC plays a major role in working memory and it is possible that, in pure consciousness, it acts to block all inputs that ordinarily converge into it, such as those from the sensory, long-term memory, limbic and other areas of the brain (LeDoux, 2006). However, research by Northoff (2003) indicates that the dorsolateral PFC is more involved in conceptual reappraisal of experience, while the medial and ventro-medial prefrontal cortex is activated in a more immediate phenomenological character of experience. Therefore, it is likely that the most significant neural correlates of pure consciousness are located in the medial areas of the prefrontal cortex.

Since nondual awareness is the pure consciousness occurring with experiences, and is space-like, the neural correlates of nondual awareness involve the areas of the pre-frontal cortex which mediate the pure consciousness, together with the areas in the posterior parietal cortex which mediate the experience of space. This idea agrees with the description of nondual awareness in the Dzogchen tradition as the intrinsic awareness that realizes the space of being (Reynolds, 1989). It extends the research of Davidson's group (Davidson et al, 2004; Lutz et al, 2004;), which identifies the fronto-parietal synchrony in gamma

range as the signature of open-ended attention, accompanied with deafferentation of the orbitofrontal cortex which is involved in judgment and evaluation.

However, the axonal thalamo-cortical origination of the synchrony in gamma range has not been found. Instead, Hamerhoff (2005a) hypothesizes that the gamma range synchrony is due to dendritic gap-junction synapses within the cortex itself. In this hypothesis, the gap junction hyper-neurons formed temporarily through such connections are the neural correlates of consciousness. Hameroff (2005a) regards the gamma synchrony in 40Hz range as the electrophysiological correlate of ordinary human consciousness, and the synchrony in the higher frequencies of 80-120 Hz found in some long-time Tibetan Buddhist practitioners, as representing the highest development of human consciousness. Crick & Koch (2005), point to the claustrum as the missing link in the neural correlate of consciousness, due to its hypothesized role in connecting all areas of the cortex, and especially in coordinating the fronto-parietal cortico-cortical connections. These direct connections between the frontal and the parietal cortex may be involved in the gamma range synchronies found during nondual awareness meditation.

Lateralization and asymmetry in the prefrontal cortex found by Davidson's team, (as well as by this researcher, as shown in the Appendix)—significant increase in the activity of the left dorsolateral pre-frontal cortex—brings into question previous conclusion that the neural correlates of pure consciousness are in the medial areas of prefrontal cortex. However, this difference is due to the similarity of pure consciousness to the deep sleep, in

contrast to nondual awareness, which functions as the context of daily experiences. Nondual awareness is characterized by being fully awake and present to the spontaneous unfolding of one's experiences. Thus, the dorso-lateral prefrontal cortex does not exercise the blocking activity, as it does during pure consciousness. Rather, it functions in its natural role as a part of the executive attention network (Fan, McCandliss, Fossella et al., 2005).

The differential increase of activity in the left dorso-lateral prefrontal cortex during meditation has been associated with the increase in the feelings of happiness and joy (Aftanas & Golosheykin, 2001; Davidson, 2004). This increase can also be interpreted from the viewpoint of traditional meditation theory: the 'left' energy channel sustains the experience of bliss dimension of nondual awareness, which in the ordinary dualistic mode of cognizing becomes the experience of craving and desire; while the 'right' channel sustains the experience of clarity or luminosity dimension of nondual awareness, which in the ordinary dualistic mode of cognizing becomes the experience of anger and frustration (Guenther, 1977). This could explain the increase of activation in the right dorsolateral prefrontal area during stressful situations, as anger builds up and clarity is needed. The medial and ventro-medial prefrontal cortex, which in this analogy corresponds to the central channel that sustains the experience of emptiness, would then be more involved in mediating pure consciousness and the open-ended empty aspect of nondual awareness.

Recent findings indicate that the human brain is intrinsically organized into two functionally anti-correlated neural networks: the extrinsic network consisting primarily of the dorso-lateral prefrontal cortex, the anterior cingulate gyrus and the lateral parietal cortex, and the intrinsic network consisting primarily of the medial pre-frontal cortex, the medial parietal cortex, the posterior cingulate gyrus, and the pre-cuneus (Fox et al, 2005; Raichle et al., 2001; Raichle & Gusnard, 2005). The extrinsic network is related to attention and working memory, while the intrinsic network appears to support self-referential processes (Northoff, Heinzel, de Greck et al., 2006). Furthermore, the extrinsic network is activated in the attention-demanding tasks focused on object/activity external to oneself. In contrast, the intrinsic network is activated during internally focused tasks, especially those that are relevant to one's self. This difference reflects the natural division of space into external and internal space.

The fMRI data from the single subject study of nondual awareness presented in the Appendix show activations in the areas encompassing both networks. This can be attributed to the balancing of attention and awareness between external and internal experiences. The sameness of internal and external space that characterizes nondual awareness is reflected in the simultaneous harmonious functioning of the ordinarily anti-correlated intrinsic and extrinsic neural networks. The ability of large-scale fronto-parietal synchrony found in nondual awareness to constrain cognitive and affective processes mediated by diverse cortical and subcortical structures, further indicates that the two networks are operating simultaneously.

This larger integrated network may then be the long-sought neural correlate of the unified nature of consciousness. If nondual awareness is one's 'original mind' that underlies all states and functions of consciousness even when not actualized, as held in the Asian nondual philosophies examined here, this may imply that this larger integrated neural network is the innate natural state of the brain, present as a latent potential underneath the dichotomy of ordinarily anti-correlated networks.

Since the chief characteristic of nondual awareness is the sameness of internal and external space, it is also likely that the areas in the posterior parietal cortex that mediate the experience of space, are functioning as a part of neuronal switch that operates at the onset of meditation and allows the shift from dualistic to nondual awareness.

The above then presents a model of the functioning of the brain in nondual awareness. The remainder of this chapter will reflect on the meaning of the present study in the context of the relevant literature.

Pure Consciousness and Nondual Awareness

The finding that nondual awareness is the pure consciousness functioning with experiences as space-like context, agrees with the majority of sources in the Hindu tradition of Advaita Vedanta, and in the Tibetan Buddhist traditions of Dzogchen and Mahamudra. It disagrees with the position of a number of Mahayana and Teravada schools of Buddhism, which see consciousness only as momentary dualistic subject-object cognition. Furthermore, these findings are

relevant to the general direction of the meditation research, which this researcher believes should be focused on the pure consciousness and nondual awareness. As stated in introduction, the neural correlates of consciousness cannot be found solely through researching the functions and states of consciousness. This conclusion is in agreement with Taylor (2003) and Deikman (1996). It contradicts the functionalist approach as represented by Churchland and Sejnowski (1993). However, it differs from both Taylor and Deikman, in that the emphasis in meditation research ought to be placed on nondual awareness rather then on the pure consciousness. Discovering how nondual awareness manifests in daily experiences could potentially lead to significant new understandings of the neural correlates of consciousness, since it implies that the nature of consciousness is present together with various states and functions of consciousness.

Several conclusions pertaining to the general understanding of the nature and the structure of consciousness in the Asian nondual philosophies can be recapitulated in order to further contextualize present findings.

According to Asian nondual philosophies, consciousness has the following structure: Nature>Substrate>States>Functions>Contents.

This indicates that the nature of consciousness (pure consciousness) encompasses all of its structures; the unconscious substrate encompasses the states of consciousness; the states of consciousness encompass the functions, and the functions encompass the contents. As seen in the previous research of the sources in Dzogchen, Mahamudra and Advaita Vedanta traditions, the nature of

consciousness is to be conscious. It can be described as empty, self-knowing cognizance without any content. Consciousness-as-such has been termed the pure consciousness in Advaita Vedanta; 'pure' indicating that is without any experiences and without change. In Tibetan Buddhism it is termed the 'clear light'. That pure consciousness can recognize itself or, encounter itself directly, without reliance on thoughts or imagination, as discovered in these traditions, indicates that pure consciousness is non-propositional in nature. In concluding this, the present study disagrees with those views in Western philosophy and cognitive psychology which see consciousness as being a construct and propositional in nature (Katz, 1978; Phylyshyn, 2002).

The above findings regarding the pure consciousness provide the context for discussing the more specific findings about nondual awareness in light of existing literature.

Nonduality is the central tenet of Asian philosophies. It is both the foundation and the goal of meditational philosophy-cum-praxis. Loy (1998) describes nonduality as characterized by the four features: centrally, it is an absence of subject-object dichotomy that manifests in threefold way, as nondual or pure perception, nondual or intuitive thinking, and as nondual or spontaneous acting. To this the present study adds the fourth, nondual emotion often labeled as compassion or unconditional love. Nondual awareness, from this perspective, is that aspect of consciousness that experiences or more precisely, realizes nonduality. As such, it is distinguished from the ordinary conceptual mind which cognizes dualistically, through the use of subject-object concepts. Nondual

awareness can be equated with the Hindu term *prajnana*, the Indian Buddhist *prajna*, or Tibetan term *rigpa*.

The finding that nondual awareness is pure consciousness functioning with experience as space-like context agrees with teachings on rigpa and co-emergence within the Dzogchen and Mahamudra traditions, respectively. It also agrees with certain interpretations of the parinamavada doctrine within the Advaita Vedanta. These conclusions are in agreement with the views of a number of Tibetan Buddhist philosophers such as Longchepa (Rabjam, 2001a), proponents of Vedanta such as Radhakrishnan (1995), and the Transpersonal psychologists such as Almaas (1996), Blackstone (1997, 2005) and Wilber (1987, 2000a, 2000b). The above conclusions contradict those views and theories which do not recognize the possibility of nondual awareness or the pure consciousness functioning with experiences, such as the vivartavada doctrine of Advaita Vedanta (Shepetin, 2004).

The relationship of nondual awareness and experience is sometimes termed the union of absolute and relative. It is described as the simultaneous transcendence and immanence (Radhakrishnan, 1995), or alternatively, as co-emergence (Namgyal, 2001). This means that, while nondual awareness is independent from experiences and not conditioned by them, it is at the same time an inseparable from experience, so that, phenomenologically, all experiences have the same quality of emptiness-luminosity-bliss, as does the nondual awareness itself. Thus, as metaphors state, nondual awareness and experiences are like the sun and its rays of light, or like the water and its wetness. This view is in accord

with the texts of Mahamudra tradition which term this oneness of awareness and experience "one taste", in which nirvana or nonduality and samsara or duality, are the same (Rangdrol, 1989).

It also agrees with Radhakrishnan's way of seeing this relationship of nondual awareness and experience as simultaneous transcendence and immanence (Radhakrishnan, 1995). However, the present study does not make theological inferences based on it.

This researcher proposes five stages of the realization of the union of absolute and relative, of nondual awareness and phenomenal experiencing. These can be considered as a re-formulation of the teachings on the five ranks of Zen master Tozan (Yu, 1971) in light of the Dzogchen, Mahamudra and Advaita Vedanta, as follows:

a) Absolute only: pure consciousness alone; transcendence described in vivartavada doctrine, or the clear light in anuttara tantra;

b) Relative within Absolute: experiences occur in the context of nondual awareness, like objects within space or images within a mirror;

c) Absolute within Relative: immanence described in parinamavada doctrine; all experiences appear as if made of nondual awareness itself, like pots made of clay or jewelry made of gold;

d) Co-emergence or Mahamudra: simultaneous transcendence and immanence, self-knowing nondual awareness and experiences arising inseparably together, so that the nondual awareness simultaneously knows both its nature and the nature of experiences;

e) Union or nonduality: complete oneness; one taste as inseparable being-awareness-bliss or emptiness-luminosity-bliss, Advaita Vedanta also claims that this oneness is the Self.

A statement is sometimes made by those who recognize the possibility of pure consciousness functioning with experience as nondual awareness, that since nondual awareness is experienced as space-like or identical to space, therefore nondual awareness pervades everywhere like space literally (Venkatesananda, 1984). Alternatively, since in the realization of oneness everything appears as not different from nondual awareness, therefore everything is actually made of nondual awareness or consciousness. Here, the question is whether extending the phenomenological truth to a metaphysical level constitutes a valid inference. Contrary to the general thrust of the arguments in Asian philosophies, there is no way to ascertain, either based on the experience or based on logic, whether this kind of a metaphysical idea is accurate or not. While in meditation, nondual awareness may appear to extend throughout the space and to be identical with it, whether this is true on some deeper level, beyond even the quantum energy states indicated by Bohm (1984), cannot be ascertained based on one's experience.

Thus, it is better to describe the process of realizing oneness as: the nondual awareness realizing the space of phenomena or the space of being (Sansk. Dharmadhatu), even though in terms of the subjective experience, as Longchepa points out (Rabjam 2001a), nondual awareness is identical with space.

Neural Correlates of Pure Consciousness and Nondual Awareness

This section will contextualize the findings of the present study within the relevant literature on the neural correlates of consciousness.

Chalmers (2000) distinguishes several different levels of neural correlates (NC) of consciousness: NC of the overall state of being conscious; NC of the various states of consciousness; and NC of the contents of consciousness. To this, the present study adds the neural correlates of pure consciousness or the nature of consciousness, and the neural correlates of nondual awareness, with a caveat that to understand these neural correlates the difference between the nature of consciousness on one hand, and the states, functions and contents of consciousness on the other, as outlined in the preceding pages, has to be kept in mind.

The overall state of being awake and conscious is critically dependent on the activity of the three sub-cortical structures: reticular formation of the brain stem, intralaminar nuclei of thalamus and the basal neuromodulatory nuclei (Baars, 2005a). The three natural daily states of consciousness of waking, dreaming and deep sleep (which includes all four stages of non REM sleep), are subserved by the activity of the reticular formation of brainstem, which secretes

neurotransmitters controlling the overall state of the brain's wakefulness, as well as by the inhibitory activity of the basal forebrain (Guyton, 1987). The excitatory and the inhibitory activities of these two structures influence the intralaminar and reticular nuclei of thalamus and through them the cortex (Arenender, 1996). Thus, the neural correlates of the three natural states of consciousness, waking, dreaming and deep-sleep, are found in the sub-cortical regions of the brain.

In contrast to this, the functions of consciousness are dependent on the activity of the cortex (Baars, 2005a). In addition to the sensory and motor functions, the neural correlates of all cognitive functions such as language, imagery, abstract thought, attention, memory, etc. are located in the cortex (Cabeza & Kingston, 2001). Baars (1997) describes the work of Gazzaniga who studied split-brain patients and found that the narrative self that receives and comments on the conscious sensory input is situated in the left prefrontal cortex, while its nonverbal counterpart is in the right prefrontal cortex. These and other numerous similar findings have led to the generally held view that the neural correlates of consciousness reside in the cortex, and in particular in the pre-frontal area (Crick & Koch, 1998; Koch, 2004). "The activity of all subcortical and extratelencephalic centers of the brain, regardless of how important they are for the appearance of consciousness, is never accompanied by consciousness. ...The prefrontal cortex ...[is] the highest brain center and the seat of the soul, of consciousness, personality, intelligence, and so on" (Roth, 2002, pp.79-83).

Koch (2004) postulates an intermediate level theory of consciousness according to which one is not aware either of the external world nor of the

internal thoughts and feelings, but only of their neural representations and re-representations solicited from the sensory and language areas of the brain by an unconscious homunculus located in the pre-frontal cortex (2004). This researcher agrees with his focusing of attention on the importance of the pre-frontal cortex, as well as with Searle (2005) who criticizes his theory for its extreme interpretation of the neural representations, and for the limited scope of awareness it postulates. As Searle points out, awareness of sensory representations does not preclude the existence of the external reality, nor is one aware of the sensory content only.

In addition to the view that sees the seat of consciousness as being in the cortex alone, the thalamocortical loops have been thought for some time to be the neuronal seat of consciousness. As Edelman (2004) states, the thalamocortical system, which he calls the dynamic core, speaks mainly to itself, and it is this property that distinguishes it from those structures that do not subserve consciousness.

> Higher order consciousness, which allows its possessor to be conscious of being conscious, to have a socially defined nameable self, and to have a concept of the past and the future, arises by evolution of an additional reentrant capability. This occurs when concept-forming areas involved in primary consciousness are linked by reentrant circuits to areas mediating semantic capability. …This view sees the development of reentrant pathways and circuits between the frontal and the temporal lobes as the most significant for the evolution of the higher-order consciousness.

> Furthermore, the connection between the concepts of self and time, on one hand, and the primary consciousness on the other, is believed to be instrumental in making the consciousness of consciousness possible (Edelman, 2004, p.105).

The above theory describes the mechanisms of our everyday conceptual consciousness. However, from the viewpoint of the pure consciousness it could be said that in addition to both the instinct as the way of knowing available to the primary consciousness, and the conceptual reason (that operates in words, images and numbers) available to higher-order consciousness, there is also the intuition which is the mode of knowing available to the pure consciousness and nondual awareness. In other words, to be conscious of being conscious, as a word-thought, as in thinking about one's consciousness, is very different from directly realizing the nature of consciousness, from consciousness encountering itself directly and non-conceptually. This means that the areas of the brain involved in subserving the primary consciousness or the rational-semantic consciousness may not necessarily be involved in subserving the pure consciousness. Zaidel's research confirms this consclusion: "Recognizing that the disconnected Right hemisphere is conscious provides additional evidence that language is not necessary for human consciousness" (Zaidel, 1994). Thus, consciousness knowing itself is simply the property of consciousness itself, and not the result of a particular function or content of consciousness.

Neural Correlates of Space in Nondual Awareness

The contribution of the present study to the field of meditation research and cognitive neuroscience in general, is the finding that the neural correlates of the experience of space in the posterior parietal cortex mediate nondual awareness in synchrony with medial and dorso-lateral areas of the pre-frontal cortex. This large-scale synchrony, which constrains cognitive and affective processes, indicates the activation of a larger neural network, one that integrates the ordinarily anti-correlated intrinsic and extrinsic networks.

A significant issue that needs to be addressed regarding the function of the neural correlates of space in nondual awareness concerns the difference between the extraordinary coherence and unity of the experience of space in nondual awareness, and the multiplicity of spaces that constitute one's mental experience of space. For example, four different types of mental spaces are postulated: the space of the body, the space around the body, the space of navigation, and the space of cognitive tasks (Tversky, 2001, 2002; Morrison & Tverski, 2004). These mental spaces are contrasted with the unified physical space. The question arises then: how is the space of nondual awareness related to these types of mental space? Or more precisely, is the space of nondual awareness a conceptually generated image of space? Kosslyn, Ganis & Thompson (2001) define mental image as the experience of perception without an external stimuli, created by accessing the perceptual information from memory. They point to the activations in the primary and, especially, in the secondary visual areas in the occipital cortex as the chief feature of mental imagery. Imagining space would also activate the

dorsal stream in the superior parietal areas. In addition, the middle temporal gyrus, the inferior temporal gyrus and the fusiform gyrus may be activated as well, as they are the locus of visual memories (Kosslyn & Thompson, 2003). Sample data presented in the Appendix show no activations in these areas indicating that the subject is not accessing an image of space from the memory. Thus, while it is likely that some of the areas of the brain involved in mediating nondual awareness are same as those mediating an image of space, the distinguishing feature would be the large-scale fronto-parietal synchrony, which is absent in ordinary experience, as well as, the absence of activations in the temporal cortex.

The activation of the posterior parietal areas (BA 7) mediating the experience of space in nondual awareness can be related to the theatre metaphor of Global Workspace Theory (Baars, 1997). In this metaphor, conscious content is limited to the spotlight of attention on the stage. The contents of working memory competing for attention, behind the scene context operators, and the audience of various cognitive systems, are in the dark, pre-conscious or unconscious. Nondual awareness can be compared to turning on the lights in the theatre, or at least backstage, while the show is still going on. This would correspond to activation of the posterior parietal areas involved in spatial processing, in large-scale synchrony with pre-frontal cortex. The result is a characteristic loss of foreground/background contrast, which has been reported by the meditators experienced in the practice of nondual awareness meditation (such as the subjects participating in the fMRI study of nondual awareness currently conducted by this

researcher at the Mental Imagery and Human-Computer Interaction laboratory, Rutgers University, Newark, NJ).

CHAPTER SEVEN: SUMMARY, CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH

Through theoretical research of the literature, the present study examined the hypothesis that the neural correlates of space in the posterior parietal cortex mediate nondual awareness in synchrony with the medial and dorso-lateral areas of the pre-frontal cortex. It explored current findings and the limitations of research on the neuroscience of nondual awareness, and offered a theoretical model that points to a large neural network, which integrates the ordinarily anti-correlates extrinsic and intrinsic networks, as being the long-sought neural correlate of unified consciousness.

It explored the idea of nondual awareness as held in the Asian nondual philosophies of Advaita Vedanta, Dzogchen and Mahamudra, and the contemporary meditation research in Cognitive Neuroscience. It outlined what pure consciousness is according to these Asian traditions, and examined whether nondual awareness is pure consciousness occurring with experience. It then, looked for the evidence of the neural correlates of pure consciousness in the EEG research of meditation, and analyzed the function of the neural correlates of space in meditation, from the evidence collected by the advanced neuroimaging studies such as fMRI and SPECT. In this way, the present study addressed the general lack of the recent studies of meditation, and in particular, the complete lack of the studies of nondual awareness.

The conclusion of the present study is: nondual awareness, which is pure consciousness occurring with experience, as a space-like context, is mediated by the neural correlates of space in the posterior parietal cortex, in large-scale synchrony with the areas in the medial and dorso-lateral pre-frontal cortex. This large-scale synchrony, which constrains cognitive and affective processes, indicates the activation of a larger neural network, one that integrates the ordinarily anti-correlated intrinsic and extrinsic networks. The present study suggests that this larger integrated network may be the long-sought neural correlate of the unified nature of consciousness, and may be the innate natural state of the brain, present as a latent potential underneath the dichotomy of the ordinarily anti-correlated networks.

* * *

The human brain is the most complex, highly organized matter we know of in the universe, and nondual awareness or unity consciousness is, arguably, the most advanced and mysterious state of consciousness that the human culture has ever recorded. Allowing the viewpoints of the Cognitive Neuroscience and the Asian nondual philosophies to co-exist, it can be said that the two, the brain and nondual awareness, represent the two sides of the great mystery of Being in search to know itself.

I hope that the present study makes a contribution toward this understanding.

Because meditation ultimately deals with the nature of consciousness itself, which underlies all cognitive processes, the topics of future meditation research are numerous.

To begin with, nondual awareness is regarded in the Advaita Vedanta, Dzogchen and Mahamudra traditions as an innate potential common to all humans. Future research could explore whether the large-scale fronto-parietal synchrony that is the neuronal signature of nondual awareness, already pre-exists in some form as a potential in the brain, and to what extent it integrates the ordinarily anti-correlated networks. It can then be explored whether this larger integrated network is indeed the neural correlate of unified consciousness.

In relation to nondual awareness, an important area of future research is the central channel (Sansk. sushumna nadi). Asian contemplative traditions hold that a variety of different levels and qualities of consciousness can be accessed in dependence on the placement of attention in relation to the central channel. This can mean both the vertical change of focus from chakra to chakra which results in a change of quality, such as love, will, passion, wisdom etc., and the horizontal change in relation to the center of the channel which produces the experience of different levels of subtlety, form the gross perceptual level to the most subtle level of pure consciousness.

Another area of particular interest for the research of nondual awareness are the occipital lobes. Ordinarily, the occipital lobes are not thought to be involved in generating awareness. However, in addition to processing visual stimuli, they also function in activating the frontal, parietal and temporal lobes.

This can be related to the traditional descriptions of consciousness that compare consciousness with light, and the lack of consciousness with the darkness, and also the light with the enlightenment or the awakening of consciousness to itself. These statements might indicate involvement of the pineal gland as well, due to its effect on regulating the light-dark cycle. Future research of the occipital lobes and the pineal gland functions in nondual awareness may lead to an evolutionary hypothesis of consciousness, according to which the experiences of space and light are the most basic elements necessary for the emergence of self-aware consciousness, since they are phenomenologically its two main characteristics.

The present research on the neural correlates of space in nondual awareness makes a contribution toward the goal of finding the neural correlate of consciousness. This, in turn, would advance the possibility of finding whether the continuum of consciousness is independent of the physical body, as many contemplative traditions assert. Resolving this issue would constitute a major social and cultural breakthrough.

APPENDIX: DATA SAMPLE

The following are preliminary fMRI data obtained from a single subject during nondual awareness meditation. This scan is a part of the larger study of the neural correlates of nondual awareness presently conducted by this researcher at the Visual/Spatial Cognition and Computer-Human Interaction laboratory at the Rutgers University, Newark, NJ. The data is used here as an illustration only, and does not constitute the main body of research in this dissertation.

Experimental Procedure

Subject, the author of this dissertation, was a forty-six year old male, right handed, with twenty-five years of meditation experience, mostly in the Tibetan Buddhist tradition. He was familiar with MRI procedures. The scan was performed in the late afternoon. The subject had his usual cup of coffee in the morning and no other stimulants or depressants in the intervening time. Previous research indicates that the length of meditation practice differentially affects cerebral blood flow and cortical activation, resulting in the larger increase of BOLD signal among the long-term meditators compared to novices (Brefczinski-Lewis et al. 2005).

Stimulation protocol was a block design: 20 second rest, 3 minute meditation, 20 s rest, 3 min counting (adding simple numbers). This was repeated two times, and this series was run once. The duration of the protocol was limited by the time constraints. More repetitions would have increased the power of

analysis. The 20 second rest periods were used in order to allow the hemodynamic response to return to normal, and are considered sufficient time for this to occur (Goebel & Jansma, 2004). Counting consisted of adding single digit numbers while focusing on the point between eyebrows, to underscore the difference between the evenly spread attention of nondual awareness, and the focused attention of conceptual mental activity. In the Asian contemplative traditions, meditation is believed to permanently alter the mental functioning of long-term meditators. fMRI evidence for these claims is beginning to emerge (Davidson, 2004b). It is thus possible that both long-term and short-term effects of meditation extended into counting condition. However, the change in the manner of deploying attention was intended to control for this. The entire procedure was performed in a dimly lit scanner room, to reduce possible distraction due to visual stimuli. Another run not represented in the images shown here, repeated the same procedure but with eyes open and while looking at an image of a mandala.

Scans were acquired using the Siemens-Fujitsu 3 Tesla Allegra scanner with full head RF coil. Changes in BOLD signal were measured using a gradient-echo echoplanar sequence (TR = 2000, TE = 30, 32 axial slices, 4mm thickness, 0 gap, matrix resolution 64x64, 411 measurement total). During the same run, both T2 saggittal and T1 axial anatomical scans were obtained, which were used to overlay the functional data.

Data Analysis was performed with Brain Voyager QX software. Stimulation protocol was created alternating the three conditions in the above-mentioned order. Data preprocessing involved 3-D motion correction, slice scan

time correction and temporal data smoothing. Spatial smoothing was not performed in order avoid blurring (Goebel & Jansma, 2004). General Linear Model (GLM) was used to analyze the whole brain data. (Region of interest, ROI, analysis will be performed at a later date.) GLM is a standard method of analysis for fMRI software today. For analyzing the functional brain images, it is a considerably more powerful analysis method then a simple correlation or t-test, as it can specify many explanatory variables or predictors. In order to remove the noise and increase accuracy of detection, the threshold clustering was set at 8 voxels, and the p value low at 0.000003.

> Using the General Linear Model, the statistical model specified in a design matrix is compared with a measured time course at each voxel. The comparison of the model and the data is expressed as an R or F value for each voxel, which tells how good the overall model fits or explains the data. If the R or F value of a voxel passes a statistical threshold, the respective voxel will be highlighted by appropriate color coding (Goebel & Jansma, 2004, p. 19)

The images that follow represent statistically significant activations in yellow or red square dots. Images #1 to #7 show the areas where activation was higher during nondual awareness meditation compared to the rest. Image #8 shows the area where the activation was higher during meditation then during the counting (meditation compared to rest minus counting compared to rest). Graphs showing the time course, and the fMRI response (as changes in the percentage of

BOLD signal, with error bars, and the time in slices on the horizontal axis), are provided for the most relevant areas of activation.

Results and Discussion:

Image 1 represents 32 axial slices through the brain, top to bottom, in radiological fashion with left and right sides reversed, showing activations during nondual awareness as compared to the rest condition. The following selection of slides describes the activations in more detail.

Image 2 (slide 7) shows activations during nondual awareness meditation compared to the rest condition, in the somatosensory cortex (BA 1,2 & 3), which is associated with the overall awareness of sensations/energy during meditation, as well as in the right posterior superior parietal area (BA 7), which is associated with the space-like quality of nondual awareness.

Image #2a shows the graphs for the time course and the fMRI response for the posterior parietal area BA7. As mentioned previously, both meditation and counting engage the parietal cortex in the overlapping areas. The activation in this area during nondual awareness is higher then during the rest, but lesser then during counting.

Image #3 (slide 9) shows the activations in the inferior parietal cortex that have been associated with spatial explorations and orienting in space, (Karnath, 1999). These activations may indicate the spatial dimension of nondual awareness. As with the posterior parietal cortex, the activations during counting

were higher then during meditation, due to the function of this area in processing mathematical operations (Hubbard, Piazza, Pinel et al. 2005).

Image 4 (slide 15) depicts activations in the left dorso-lateral prefrontal cortex (BA 45, 46, 9), which has been found to be significantly involved in subserving the bliss and compassion dimensions of nondual awareness (Davidson et al. 2004); as well as participating in the fronto-parietal EEG synchrony characteristic of certain types of meditation (Lutz et al. 2004).

Image #5 (slide 19) again depicts activation in dorso-lateral prefrontal cortex, (areas BA 46, 45,), together with the activations in occipito-parietal junction (areas 39 and 37) which participate in integrating experience into coherent whole—the 'wholeness' of experience is one of the hallmarks of nondual awareness. Activations within the occipital cortex (BA 17, 18) indicate the involvement of visual areas even in the absence of visual stimuli. This may correlate with the perceived luminosity of nondual awareness and with the traditional descriptions of consciousness that compare consciousness with light, and the lack of consciousness with the darkness.

Image #6 (slide 21) shows significant new activations in the medial pre-frontal and the anterior cingulate cortex (BA 32, 24). This area of the brain has been associated with the ability to hold attention during meditation (Lazar, 2000), and is a part of the intrinsic network (Raichle et al., 2001). Graphs show higher activation in this area during meditation then during counting, even though the counting was a more narrowly focused activity. This may also be due to the fact that this area mediates a sense of self, thus possibly indicating that the self is an

integral dimension of nondual awareness and of consciousness in general (Feinberg and Keenan, 2005).

Image #7 (slide 23) shows again the activation in the anterior cingulate gyrus and the visual cortex. New activations are in the medial and ventro-medial prefrontal cortex (BA 10, 11), the areas that have been associated with direct non-conceptual experiencing (Northhoff, 2003), which is the mode of experiencing of nondual awareness.

Image #8 (slide 25) shows the areas in the brain where the activation was higher during meditation then during the counting (meditation compared to rest minus counting compared to rest). Since counting is a conceptual activity involving focusing, higher activations were found during counting then during meditation in those areas that are required for mathematical processing, in the pre-frontal and parietal cortex (Hubbard et al. 2005). The only area with statistically significant higher activation during nondual awareness meditation then during counting in this subtraction was is the right inferior occipito-temporal cortex (BA 37), which is associated with integration of sensory stimuli. Interestingly, it is also one of the only two areas (the other being anterior insula), where the increase of cortical thickness due to meditation correlates with the length of meditation practice (Lazar, 2005).

Image # 1

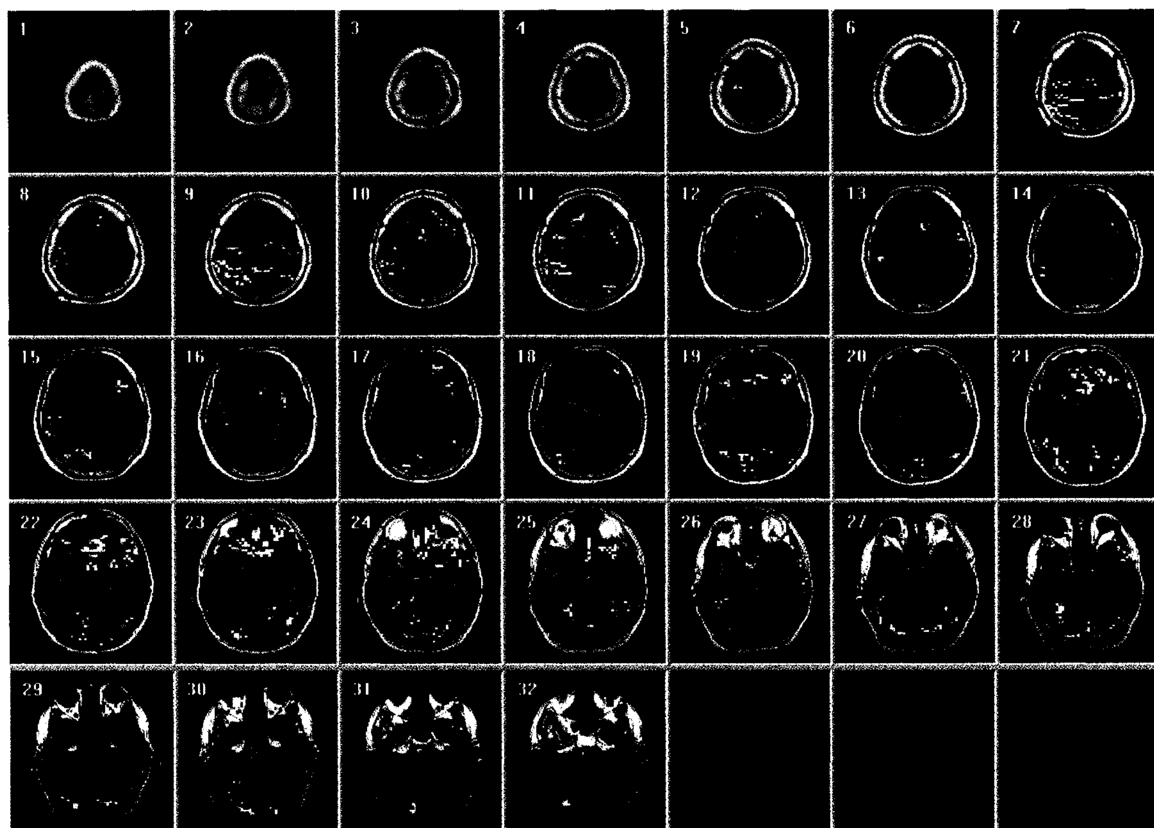

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Image #2

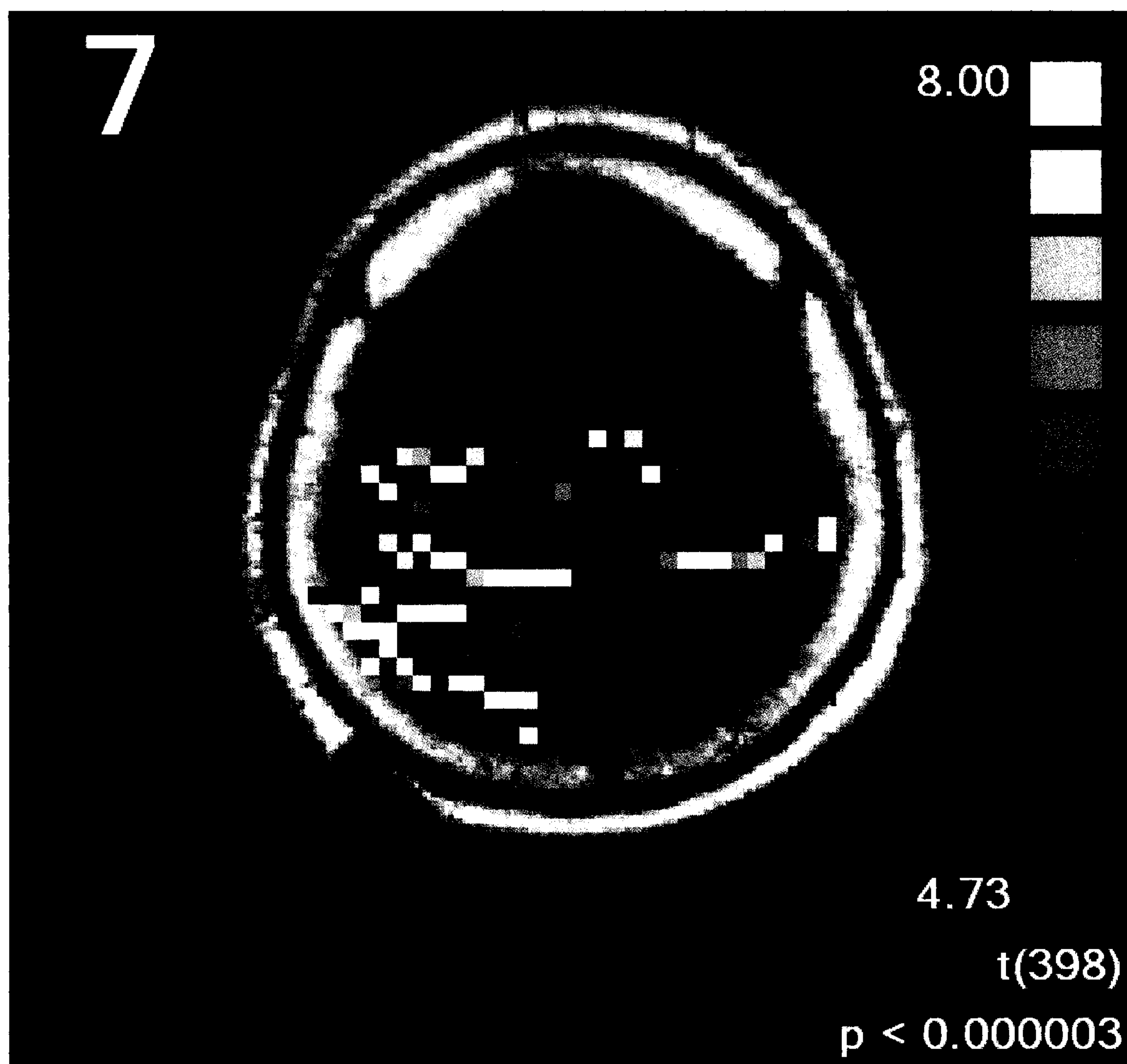
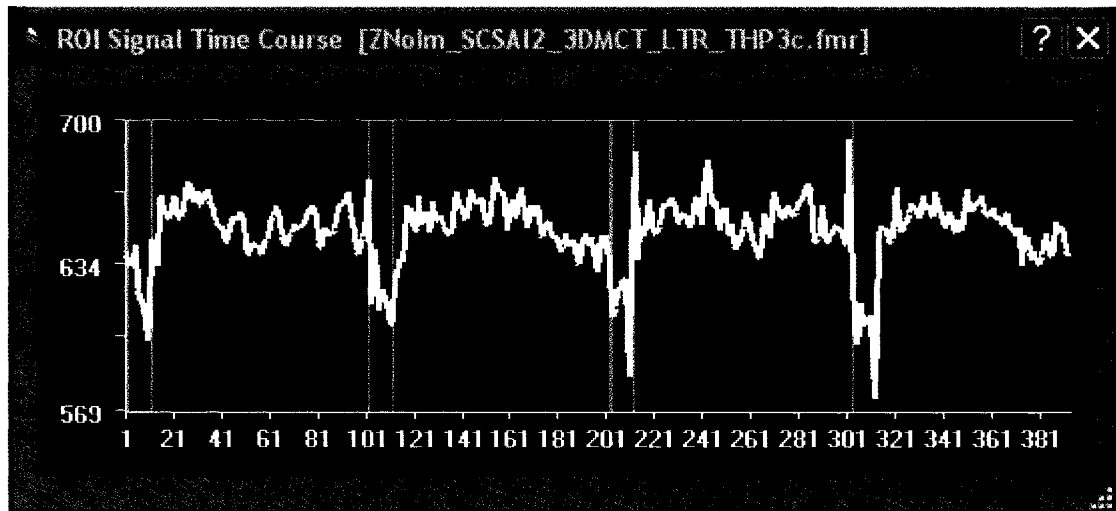


Image #2a

Signal Time Course and FMRI response for the right posterior superior parietal cortex (BA 7): green-rest; blue-meditation; gray-counting.



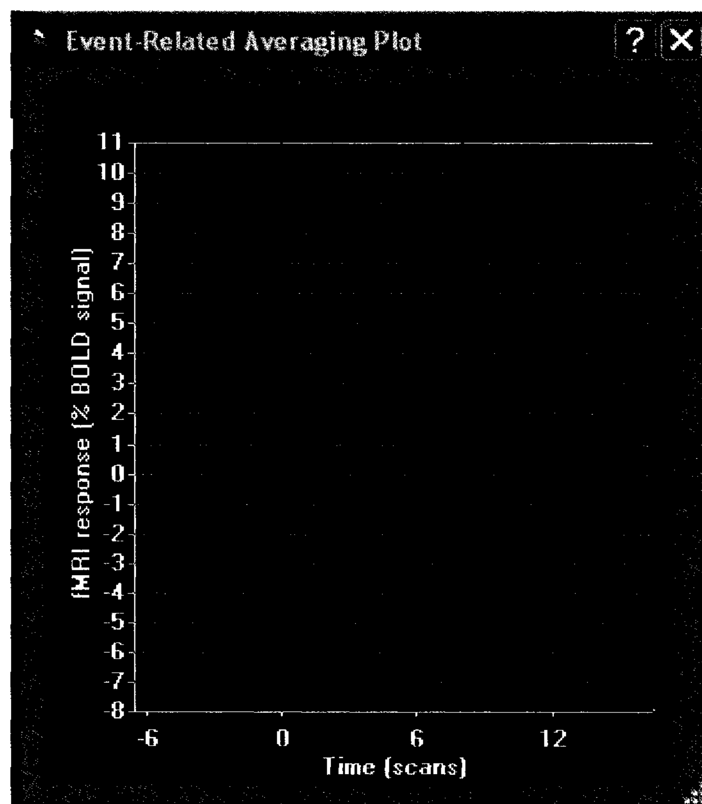


Image #3

Inferior parietal cortex (BA 40)

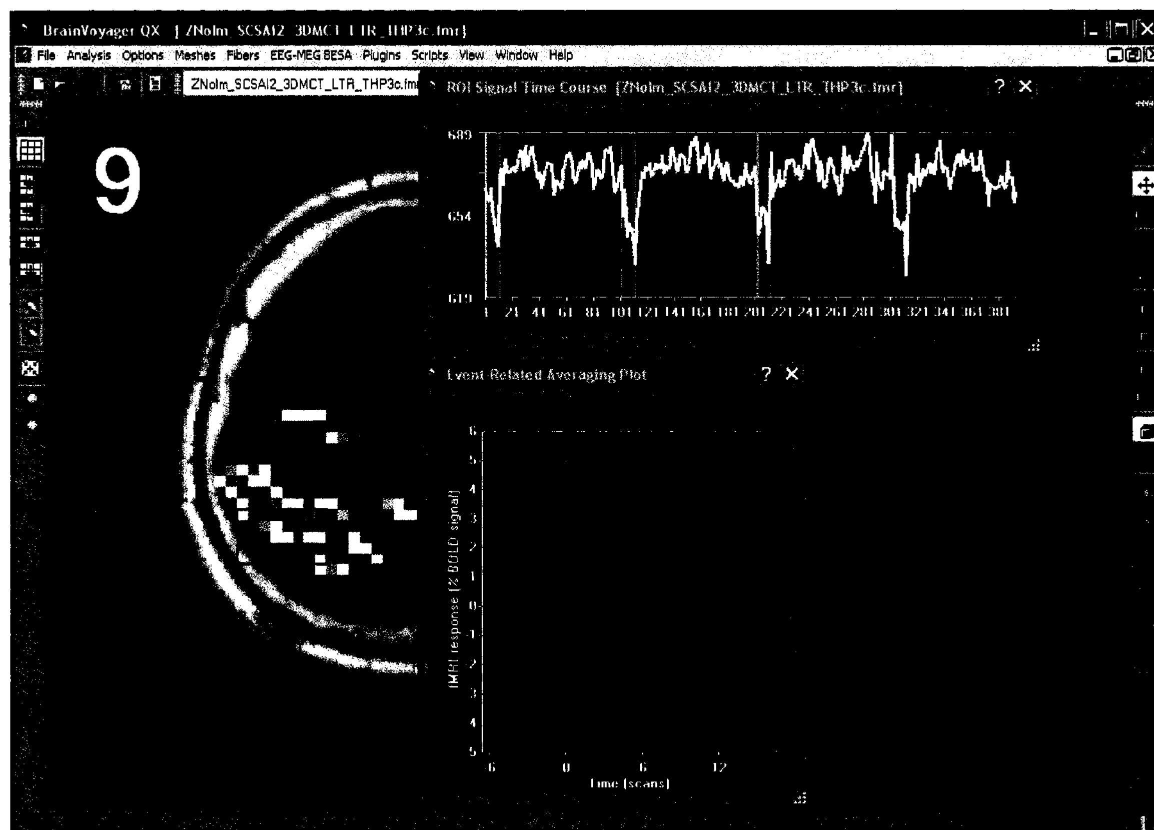


Image #4

Left dorso-lateral pre-frontal cortex (BA 9, 45, 46)

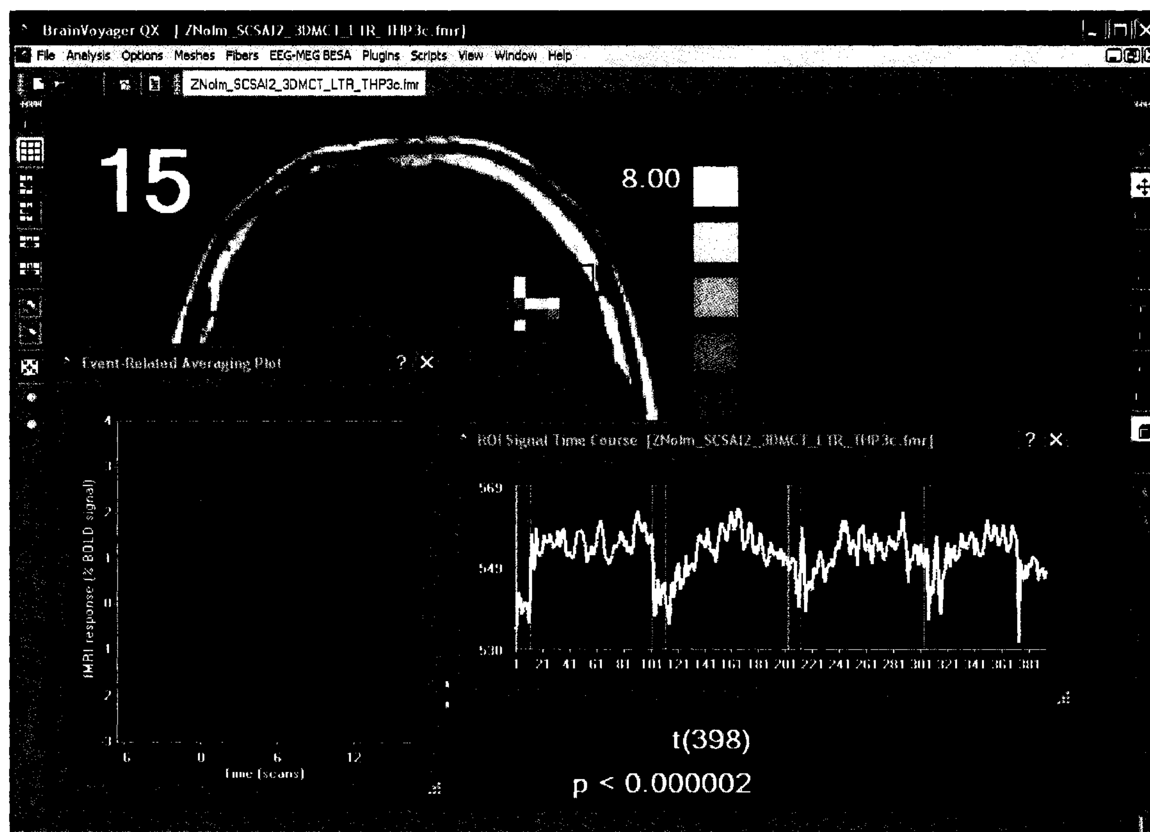


Image #5

DLPFC (BA 45, 46), Occipital (BA 17, 18) and Occipito-temporal (BA 37, 39)

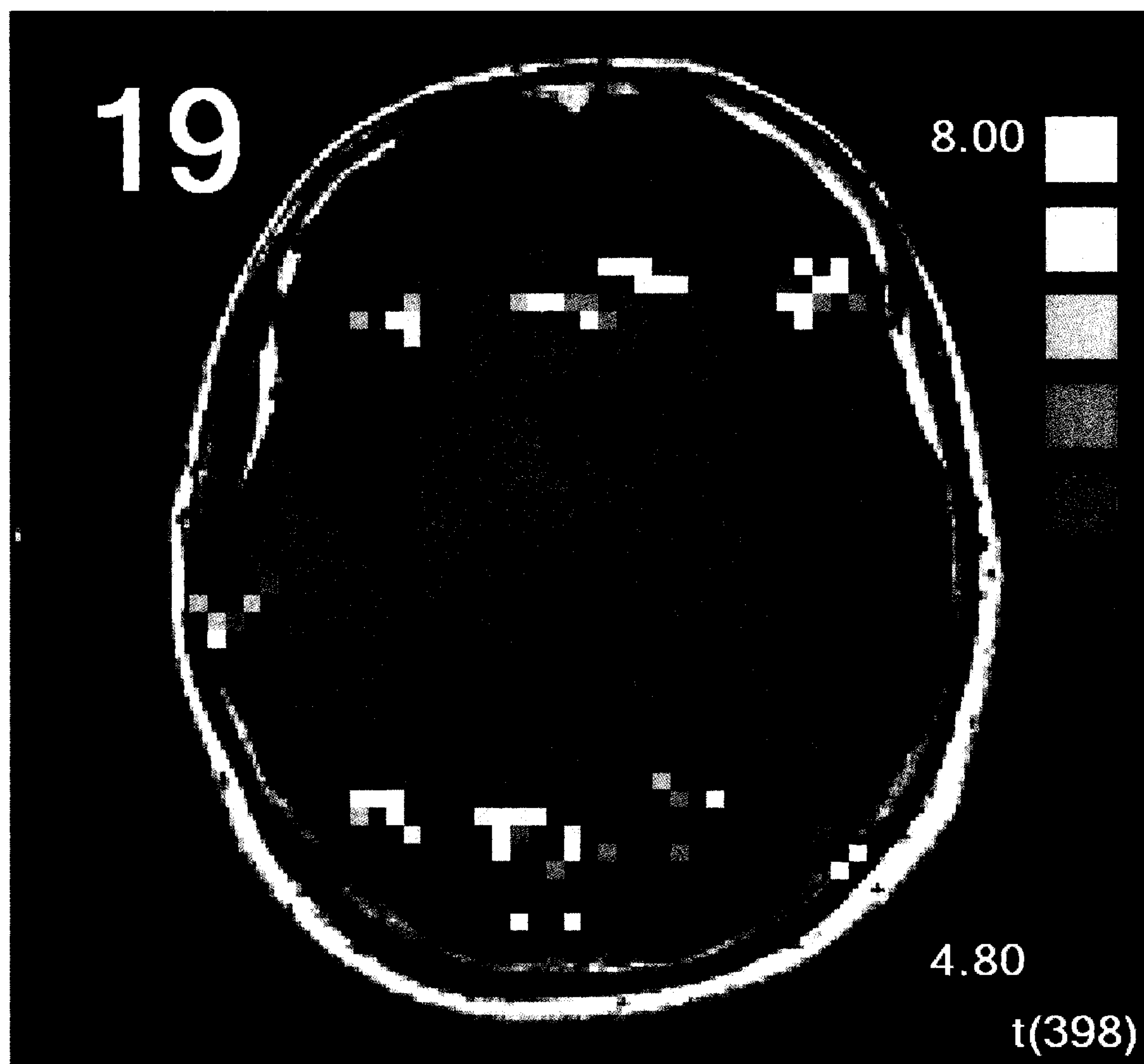


Image #6

Medial pre-frontal cortex and anterior cingulate gyrus (BA 10, 24, 32)

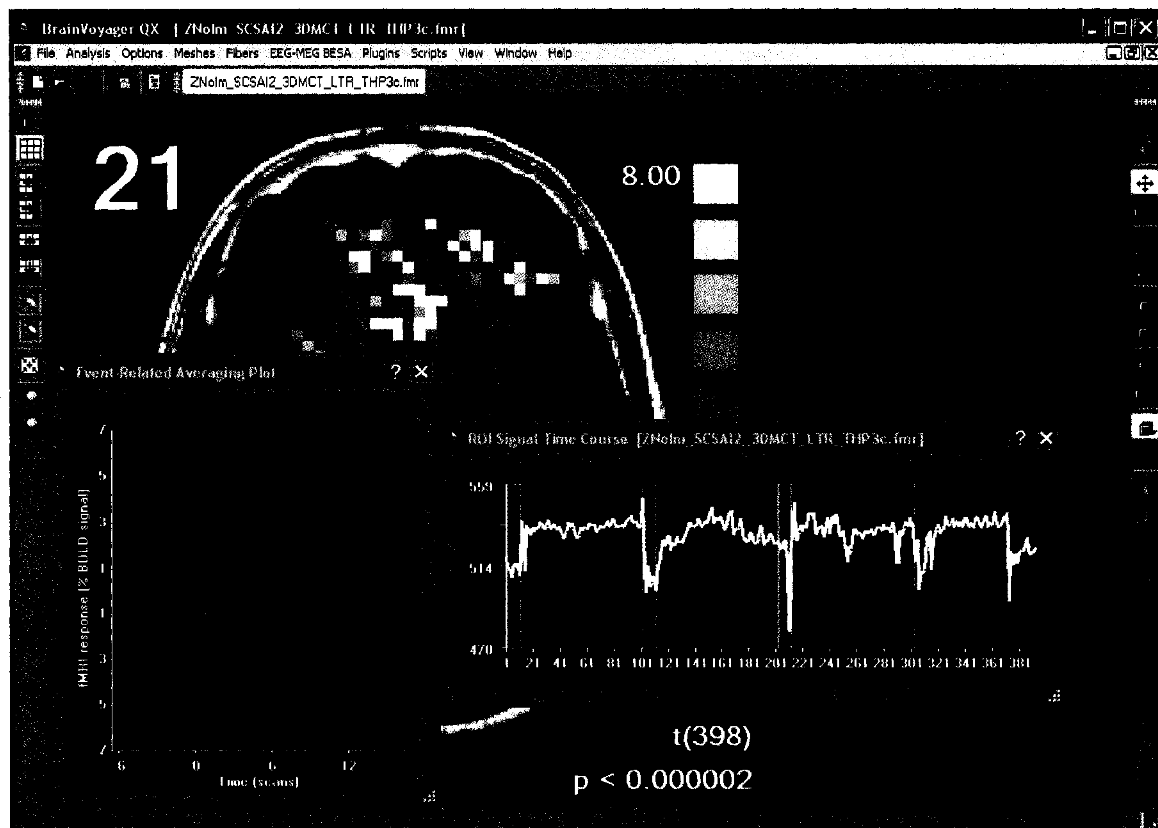


Image #7

Medial and ventral-medial pre-frontal cortex (BA 10,11).

Higher visual areas in the occipital cortex and the occipito-temporal cortex

(BA 18, 19, 37).

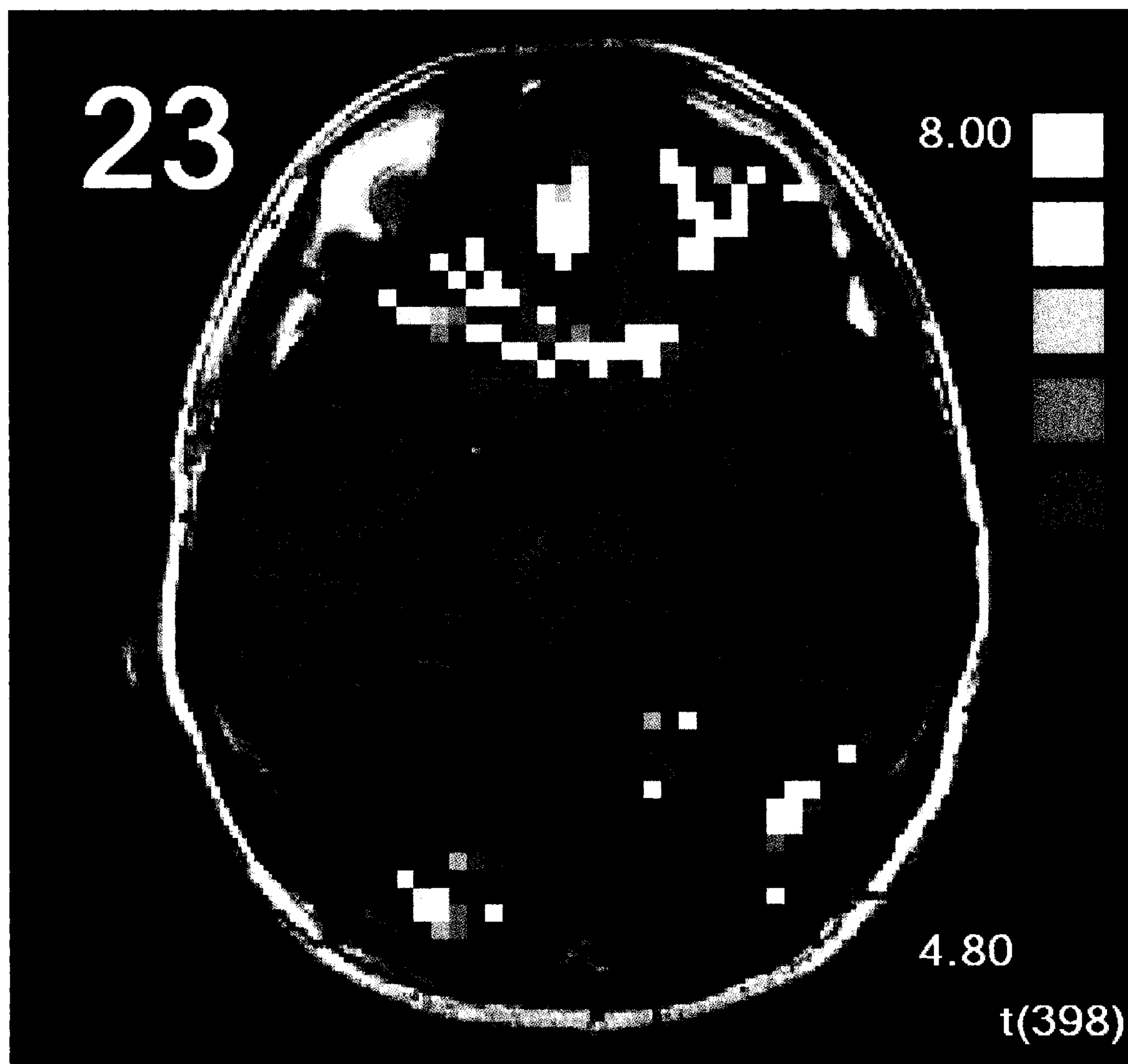
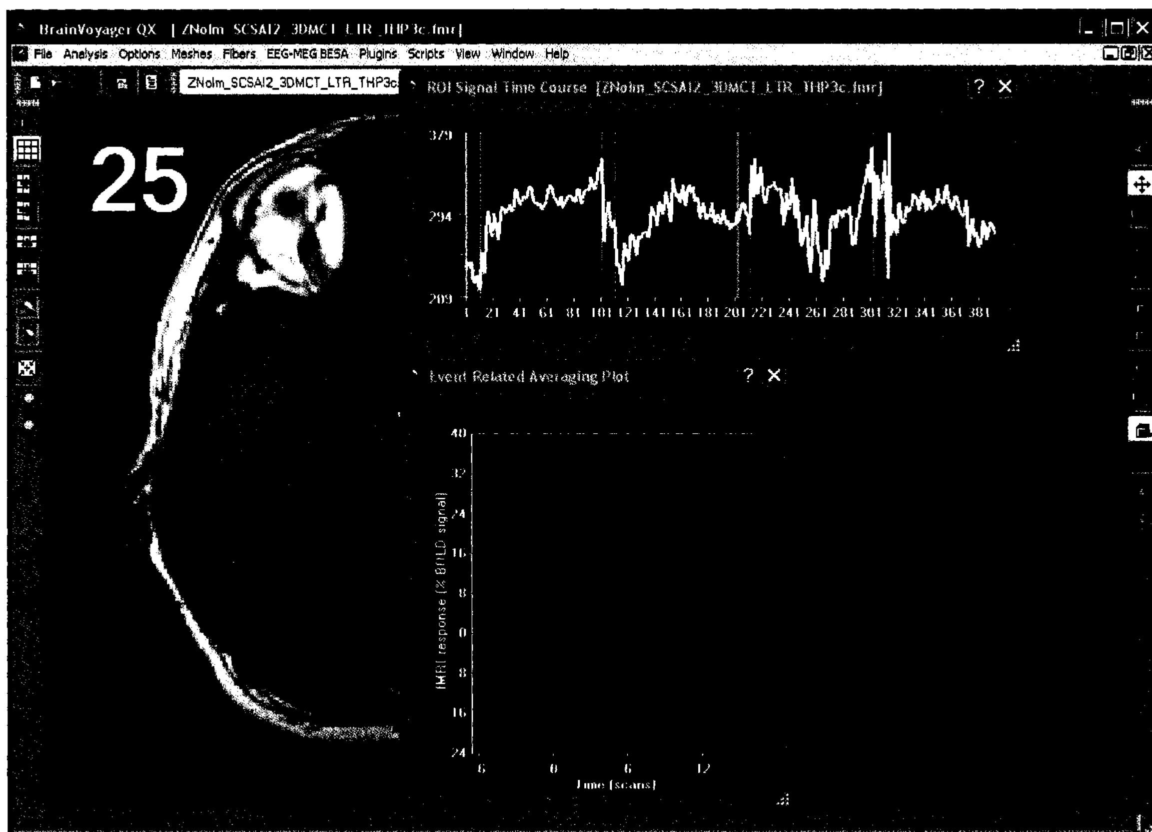


Image #8

Meditation minus counting in the inferior occipito-temporal cortex (BA 37)



REFERENCES

Aftanas, L.I. & Golosheykin, S.A. (2001). Human anterior and frontal midline theta and lower alpha reflect emotionally positive state and internalized attention: high-resolution EEG investigation of meditation. *Neuroscience Letters, 310,* (57-60).

Aiyar, K.N. (1914). *Thirty Minor Upanishads.* Madras, India.

Albahari, M. (2002). Against no-Atman theories of Anatta. *Asian Philosophy, 12,* (1), 5-16.

Almaas, A.H. (1996). *The Point of Existence: Transformations of Narcissism in Self-Realization.* Berkeley, CA: Diamond Books.

Almaas, A. H. (1986). *Essence.* York Beach, MA: Samuel Weiser, Inc.

Anand, B.K., Chhina, G., Singh, B. (1961). Some aspects of Electroencephalographic studies of Yogis. *Electroencephalography and Clinical Neurophysiology, 13,* 452-456. In Shapiro, D. & Walsh, R. (Eds.) (1984). *Meditation: Classic and Contemporary Perspectives.* (pp. 480-492). Hawthorne, NY: Aldine Publishing.

Ananda, B. (March 25, 2005). Lecture on vipassana at Rutgers University, NJ

Anderson, R. A. (1999). Multimodal integration for the representation of space in the posterior parietal cortex. In N. Burgess, K. Jeffery, & J. O'Keefe (Eds.), *The Hippocampal and Parietal Foundations of Spatial Cognition,* (pp. 90-103). Oxford, UK: Oxford University Press.

Andresen, J. (2000). Meditation meets Behavioural Medicine. *Journal of*

Consciousness Studies, 7, (11-12), 17-73.

Andresen, J. & Forman, R.K.C. (2000). Methodological Pluralism in the Study of Religion. *Journal of Consciousness Studies, 7* (11-12), 7-14.

Aranya, S. H. (1983). *Yoga Philosophy of Patanjali.* Albany, NY: SUNY Press.

Arenander, A., Sheppard, W. & Gunes Yucel, H. (2000). *The Effects of the Transcendental Meditation Technique on the Temporal and Spatial Mapping of the Brain—a MEG Study.* Brain Research Institute, Fairfiled, IA

Arenander, A. (1996) *Global Neuronal Ground State.* Brain Research Institute, Fairfiled, IA

Atmaroopananda, S. (2004). Talks on the doctrines of Advaita Vedanta. Ridgley, NY: Vivekananda Center.

Aurobindo, S. (1996). *The Upanishads.* Pondichery, India: Sri Aurobindo Ashram.

Austin, J. (1998). *Zen and the Brain.* Cambridge, MA: MIT Press

Austin, J., (2000). Consciousness Evolves when Self Dissolves. *Journal of Consciousness Studies, 7,* (11-12), 209-300.

Baars, B. J. (1997) In the theatre of consciousness. *Journal of Consciousness Studies, 4,* (4), 292-309.

Baars, B. J. (2004). Toward the Science of Consciousness, Tucson Conference April, 2004.

Baars, B. J. (2005a). Subjective experience is probably not limited to humans: the evidence from neurobiology and behavior. *Consciousness and Cognition,*

14, (1), 7-12.

Baars, B. J. (2005b). personal email on the issues in fMRI analysis.

Baerentsen, K.B., Hartvig, N.V., Stodkilde-Jorgensen, H. & Mammen, K. (2001). Onset of Meditation Explored with fMRI. *NeuroImage 13*, (2), 297-297.

Baerentsen, K.B., Harmann, T., Green, A.C., Stodkilde-Jorgensen, H. & Mammen, K. (2004). Zen Meditation: An Investigation Using fMRI. Poster Number: TH 7 at Human Brain Mapping 2004.

Banquett, J.P. (1973). Spectral analysis of EEG in meditation. *Electroencephalography and Clinical Neurophysiology, 35,* 143-151.

Becker, D.E. & Shapiro, D. (1981). Physiological responses to clicks during Zen, Yoga and TM meditation. *Psychophysiology, 17,* 385-389.

Beiman, I.H., Johnson, S.A., Puente, A.E., Majestic, H.W. & Graham, L.E. (1984). The relationship of client characteristics to outcome for TM, behavior therapy, and self-relaxation. . In Shapiro, D. & Walsh, R. (Eds.) (1984). *Meditation: Classic and Contemporary Perspectives.* (pp. 565-571). Hawthorne, NY: Aldine Publishing.

Benson, H. (1975). *Relaxation Response.* New York, NY: William Morrow.

Benson, H. (1976). The relaxation response and cardiovascular diseases. *Chest, Heart, Stroke Journal, 1,* 28-31.

Benson, H. (1977). Systemic hypertension and the relaxation response. *New England Journal of Medicine. 296,* 1152-1156.

Benson, H., Frankel F.H. & Apfel, R. (1978). Treatment of Anxiety: Comparison

of the usefulness of self-hypnosis and a meditational relaxation technique. *Psychotherapy and Psychosomatics, 30,* 229-242.

Blackmore, S. (2004). *Consciousness: An Introduction.* Oxford, UK: Oxford University Press.

Blackstone, J. (1997). *The Enlightenment Process.* Rockport, MA: Element.

Blackstone, J. (2005). *The Relevance of Nondual Realization for the Psychotherapeutic Process.* Doctoral dissertation, Union Institute and University, Cincinnati, OH.

Block, N. (2005). Two Neural Correlates of Consciousness. *Trends in Cognitive Science, 9,* (2), 1-6.

Bohm, D. (1984). *Wholeness and the Implicate Order.* London, UK: Routledge, Kegan & Paul.

Brefczynski-Lewis, J.A., Lutz, A. & Davidson, R. (2005) *A Neural Correlate of Attentional Expertise in Long-Time Buddhist Practitioners.* Keck Laboratory, University of Wisconsin, Madison, WI.

Brett, M., Johnsrude, I.S., & Owen, A.M. (2002). The problem of functional localization in the brain. *Nature Reviews Neuroscience, 3,* 243-249.

Brooks, R. W. (1968). *The Rope and the Snake: An Investigation of the Concept of Adhyasa (Superimposition) in Advaita Vedanta.* Doctoral Thesis, University of Minnesota.

Brown, D., Forte, M. & Dysart, M. (1984). Visual sensitivity and mindfulness meditation. *Perceptual and Motor Skills 58*, (3), 775-784.

Brown, V. W., (2001). Neurofeedback and Lyme's disease: A clinical application

of the five phase model of CNS functional transformation and integration; *Journal of Neurotherapy, 1-2*, (6), 23-29.

Bujatti, M. & Reiderer, P. (1976). Serotonin, noradrenaline, dopamine metabolites in transcendental meditation-technique. *Journal of Neural Transmission,* 39, (3), 257-67.

Burgess, N., Jeffery, K., & O'Keefe, J. (1999). *The Hippocampal and Parietal Foundations of Spatial Cognition*, Oxford, UK: Oxford University Press.

Cabeza, R. & Kingston, A. (2001). *Handbook of Functional Neuroimaging of Cognition.* Cambridge, MA: MIT Press.

Cahn & Polich, (in press). Meditation states and traits: EEG, ERP and Neuroimaging studies. *Psychological Bulliten.*

Canter, P. H., & Ernst, E. (2003). The cumulative effects of Transcendental Meditation on cognitive function—a systematic review of randomized controlled trials. *Wien Klin Wochenschr, 115,* (21-22), 758-766.

Carter, O.L., Presti, D.E., Callistemon, C., Ungerer, Y., Liu, G.B. & Pettigrew, J.D. (2005). Meditation alters perceptual rivalry in Tibetan Buddhist monks. *Biology 15,* (1), 412-413

Chagme, K. (1998). *A Spacious Path to Freedom.* Ithaca, NY: Snow Lion.

Chalmers, D. (1996). *The Conscious Mind.* New York, NY: Oxford University Press.

Chalmers, D. (2000). What is a Neural Correlate of Consciousness? In Metzinger, T. (Ed.), *Neural Correlates of Consciousness,* Cambridge, MA: MIT Press.

Caspi, O. & Burleson, K.O. (2005). Methodological challenges in meditation research. *Advances in Body-Mind Medicine, 21,* (1), 4-11.

Chawkin, K. (2002) *Pioneering Study Quantifies Brain Wave Patterns During Higher Human Functioning*. Fairfield, IA: MUM Press Release.

Churchland, P. S. & Sejnovski, T. J. (1993). *The Computational Brain.* Cambridge, MA: MIT Press.

Cohen, M.S., & Bookheimer, S.Y., (1994). Localization of Brain Function Using Magnetic resonance Imaging. *Trends in Neuroscience, (17)* 7, 17-28.

Colby, C. L.(1999); Parietal cortex constructs action-oriented spatial representations. In N. Burgess, K.Jeffery, & J. O'Keefe (Eds.), *The Hippocampal and Parietal Foundations of Spatial Cognition*, (pp. 104-126). Oxford, UK: Oxford University Press.

Comans, M. (1993). The Question of the Importance of Samadhi in Modern and Classical Advaita Vedanta. *Philosophy East and West 43,* (1), 19-38.

Cromie, W.J. (2002). Meditation Changes Temperature. *Harvard University Gazette, April 18, 2002.*

Cozort, D. (1986). *Highest Yoga Tantra.* Ithaca, NY: Snow Lion.

Crick, F. & Koch, C. (1998). Consciousness and Neuroscience. *Cerebral Cortex, 8,* 97-107.

Crick, F. & Koch, C. (2005). What is the role of the claustrum? *Phil. Trans. R. Soc. B. 360,* 1271-1279.

Dalai Lama, T.G. (1980). *Tantra in Tibet.* London, UK: George, Allen & Unwin.

Dalai Lama, T.G. (1985). *Kindness, Clarity and Insight.* Ithaca, NY: Snow Lion.

Dalai Lama, T.G. (1997a). *Sleeping, Dreaming, and Dying.* Ithaca, NY: Snow Lion.

Dalai Lama, T.G. (1997b). *The Buddha Nature.* Woodside, CA: Bluestar Communications.

Dalai Lama, T.G., et al. (1999). *Consciousness at the Crossroads.* Ithaca, NY: Snow Lion.

Dalai Lama, T.G. (2003). *The Mind of Clear Light.* Ithaca, NY: Snow Lion.

Dalai Lama, T.G. (2004). *Dzogchen.* Ithaca, NY: Snow Lion.

D'Aquili, E. (1978). The neurobiological bases of myth and concepts of deity. *Zygon, 13,* 257-275.

D'Aquili, E. & Newberg, A. (1999). *Mystical Mind: Probing the Biology of Religious Experience.* Minneapolis, MN: Fortress Press.

Darling, G. J. (1987). *An Evaluation of the Vedantic Critique of Buddhism.* Delhi, India: Motilal Banrsidass.

Davidson, R.J. (2000). Affective neuroscience and psychophysiology. *Psychophysiology. 40,* 655-665.

Davidson, R.J. (2004a). What does the prefrontal cortex "do" in affect: Perspectives on frontal EEG asymmetry. *Biological Psychology, 67,* 219-233.

Davidson, R.J. (2004b). Research presented at Mind & Life Summer Research Institute. Garrison Institute, Garrison, NY, June 21-28, 2004.

Davidson, R.J. (2004c). Research Initiatives. Retrieved on June 16, 2004 form http://www.mindandlife.org/initiatives_section.html

Davidson, R.J. (2005). Science and religion in harmony. *Nature Neuroscience, 436,* 889-889.

Davidson, R.J. (2005b). presentation at the *Investigating the Mind* conference with the Dalai Lama, Nov. 8-11, 2005, DAR Constitution Hall, Washington D.C.

Davidson, R.J., Goleman, D. and Schwartz, G. (1976). Attentional and affective concomitants of meditation: A cross-sectional study. *Journal of Abnormal Psychology, 85,* 235-308.

Davidson, R.J. & Irwin, W. (1999). The functional neuroanatomy of emotion and affective style. *Trends in Cognitive Sciences, 3*, (1), 11-21.

Davidson, R.J. & Schwartz, G. (1984). Matching relaxation therapies to types of anxiety: a patterning approach. In Shapiro, D. & Walsh, R. (Eds.) (1984). *Meditation: Classic and Contemporary Perspectives.* (pp. 622-631). Hawthorne, NY: Aldine Publishing.

Davidson, R.J., Pizzagalli, D., Nitschke, J.B., & Putnam, K. (2002). Depression: perspectives from affective neuroscience. *Annual Review of Psychology, 53*, 545-574.

Davidson, R.J., Kabat-Zinn, J., Schummacher, J., Rosenkranz, M., Muller, D., Santorelli et al. (2003). Alterations in brain and immune functions produced by mindfulness meditation. *Psychosomatic Medicine. 65,* 564-570.

Deikman, A. (1966). De-automatization of the mystic experience. *Psychiatry, 29,* 324-338.

Deikman, A. (1996). "I"=Awareness. *Journal of Consciousness Studies, 3,* (4), 350-356.

Delmonte, M.M. (1985). Meditation and anxiety reduction: a literature review. *Clinical Psychology Review, 5,* 91-102.

Deutsch, E. (1973). *Advaita Vedanta: A Philosophical Reconstruction.* Honolulu, Hawaii: University of Hawaii Press.

Dobbs, D. (2005). Fact or Phrenology. *Scientific American Mind. 16,* (1), 24-31.

Dreyfus, G. (2004). Lectures on Yogachara at the first Mind and Life Summer Research Institute, Garrison, NY, June 21-28, 2004.

Dunn, B.R., Hartigan, J.A., & Mikulas, W.L. (1999). Concentration and mindfulness meditations: unique forms of consciousness? *Applied Psychophysiology and Biofeedback, 24,* 147-164.

Edelman, G. (2004). *Wider then the Sky.* New Haven, CT: Yale University Press.

Edwards, D.L. (1991). *A Meta-analysis of the Effects of Meditation and Hypnosis on Measures of Anxiety.* DAI 52, no 2-B.

Eliade, M. (1964). *Shamanism.* Princeton, NJ: Princeton University Press.

Engel, A.K., Fries, P. & Singer, W. 2001(a). Dynamic predictions: oscillations and synchrony in top-down processing. *Nature Review Neuroscience, 2,* 704-16.

Engel, A.K.& Singer, W. 2001(b). Temporal binding and the neural correlates of sensory awareness. *Trends in Cognitive Sciences, 5,* (1), 16-25.

Esch, T., Guarna, M., Bianchi, E., Zhu, W. & Stefano, G.B. (2004).

Commonalities in the central nervous system's involvement with complimentary medical therapies: limbic morphinergic processes. *Med. Sci. Monit, 10,* (6), 6-17.

Fan, J., McCandliss, B.D., Fossella, J., Flombaum, J.I. & Posner, M.I. (2005). The activation of attentional networks. *NeuroImage, 26,* 471-479.

Farah, M.J., Hammond, K.M., Levine, D.N. & Calvanio, R. (1988). Visual and spatial mental imagery: Dissociable systems of representation. *Cognitive Psychology, 20,* 439-462.

Faw, B. (2003). Prefrontal executive committee. *Consciousness and Cognition, 12,* (1), 83-139.

Feinberg, T.E. & Keenan, J.P. (2005). *The Lost Self.* New York: Oxford University Press.

Feuerstein, G., Kak, S. & Frawley, D. (2001). *In Search of the Cradle of Civilization.* Wheaton, IL: Quest Books.

Fields, R.D. (2004). The Other Half of the Brain. *Scientific American*, April 2004, 53-61.

Forman, R.K.C. (1996). What does mysticism have to teach us about consciousness? *Journal of Consciousness Studies, 5,* (2), 185-201.

Forman, R.K.C. (1989). Paramaartha and modern constructivists on mysticism. *Philosophy East & West, 39* (4/10), 393-418.

Forman, R.K.C. (1998). *Innate Capacity.* Oxford: Oxford University Press.

Fort, A.O. (1982). Turiya and the Catuspad Doctrine in Advata Vedanta: An Inquiry into an Indian "States of Consciousness" Doctrine. Doctoral

Dissertation, University of Pennsylvania.

Fort, A.O. (1998). *Jivanmukti in Transformation: Embodied Liberation in Advaita and Neo-Vedanta.* Albany, NY: SUNY Press.

Fox, M.D., Snyder, A.Z., Vincent, J.L., Van Essen, D.C., Corbetta, M. & Raichle, M.E. (2005). Human brain is intrinsically organized into dynamic, anti-correlated functional networks. *PNAS, 102,* (27), 9673-8.

Frackowiak, R., Friston, K., Frith, C., Dolan, R. & Mazziotta J. (1997). *Human Brain Function.* San Diego, CA: Academic Press.

Fransson, P. (2004). How do you do nothing? *Human Brain Mapping 2004.* Poster number: TH 31.

Gackenbach, J.I., Heilman, N., Boyt, S., & LaBerge, S. (1985). The relationship between field independence and lucid dreaming ability. *Journal of Mental Imagery, (9),* 9-20.

Gambhirananda, S. (1990). *Mandukya Upanishad with the Commentary of Shankaracharya.* Calcutta, India: Advaita Ashrama.

Gangolli, D.B. (1991). *Intuitive Approach of Shankara's Vedanta.* Bangalore, India: Adhyatma Prakasha Karyalaya.

Garfield, J.L. (1995). *The Fundamental Wisdom of the Middle Way.* New York, NY: Oxford University Press.

Garfield, J.L. (1997). Vasubhandu's "Treatise on the Three Natures". *Asian Philosophy. 6,* (2), 133-154.

Gazzaniga, M. S., Ivry, R. B. & Mangun, G.R. (2002). *Cognitive Neuroscience.* New York, NY: W.W. Norton.

Geleg, R. (2004). Lecture at the first Mind and Life Summer Research Institute, Garrison, NY. June 21-28, 2004.

Gellhorn, E., & Keily, W.F. (1972). Mystical states of consciousness: neuropsychological and clinical aspects. *Journal of Nervous and Mental Disease, 154,* (8), 399-405.

Goebel, R. & Jansma, H. (2004). *Brain Voyager QX Guide.* Amsterdam, Holland: Brain Inovation.

Goleman, D. (1976). Meditation and Consciousness: An Asian Approach to Mental Health. *American Journal of Psychotherapy 30 (1),* 41-54.

Goleman, D. (2003). *Destructive Emotions and How We Can Overcome Them: A Dialogue with the Dalai Lama.* London, UK: Bloomsbury.

Goode, G. (2000). Retrived on June 6, 2003, from www.goups.yahoo.com/mahamudra

Greicius, M.D., Krasnow, B., Reiss, A.L., & Menon, M. (2003). Functional Connectivity in the Resting Brain: A Network Analysis of the Default Mode Hypothesis. *PNAS, 100, (1),* 253-258.

Guenther, H.V. (1976). *Kindly Bent to Ease Us.* Emeryville, CA: Dharma Publishing.

Guenther, H.V. (1977). *Tibetan Buddhism in Western Perspective.* Emeryville, CA: Dharma Publishing.

Guenther, H.V. (1984). *Matrix of Mystery.* Boulder, CO: Shambala.

Gupta, M.N. (1978). *The Condensed Gospel of Sri Ramakrishna.* Madras, India: Sri Ramakrishna Math.

Gusnard, D.A., Akbudak,E., Shulman, G.L. & Raichle, M.E., (2001). Medial prefrontal cortex and self-referential mental activity: Relation to a default mode of brain function. *PNAS, 98, (7),* 4259-4264.

Gyamtso, T. (2001). *Progressive Stages of Meditation on Emptiness.* Auckland, New Zealand: Zhyisil Chokyi Ghatsal Publications.

Gyamtso, T. (2004). *Mairtreya's Distinguishing Phenomena and Pure Being.* Ithaca, New York: Snow Lion.

Haines, D.E. (Edt.), (2002). *Fundamental Neuroscience.* Philadelphia, PA: Churchill Livingstone.

Hameroff, S. (2005a). Breakthrough study on EEG of meditation. *Science & Consciousness Review.* Retrieved on July 7, 2005 from www.sci-con.org

Hameroff, S. (2005b). Consciousness, neurobiology and quantum mechanics: the case for a connection. Retrieved from the web on September 19, 2005 at http://www.quantumconsciousness.org/springer.htm

Hamilton, S. (2001). *Indian Philosophy: A Very Short Introduction.* New York, NY: Oxford University Press.

Holt, W.R., Caruso, J.L. & Riley, J.B. (1978). Transcendental meditation versus pseudo-meditation on choice reaction time. *Perceptual and Motor Skills, 46,* (3), 74-80.

Hon, N., Duncan, J., Epstein, R. & Owen, A. (2004). On the Role of the Frontoparietal Network: Attention, Task or Awareness? *Human Brain Mapping 2004, Poster Number: TH 47.*

Houk, J.C. (2001). Neurophysiology of Frontal-Subcortical Loops. In D.G.

Lichter & J.L. Cummings, (Eds.), *Frontal-subcortical Circuits in Neurology and Psychiatry.* (pp. 92-113), New York, NY: Guilford Publications.

Hubbard, E.M., Piazza, M., Pinel, P., & Dehaene, S. (2005). Interactions between number and space in parietal cortex. *Nature Reviews Neuroscience, 6,* 435-448.

Huettel, S.A., Song, A.W., & McCarthy, G. (2004). *Functional Magnetic Resonance Imaging.* Sunderland, MA: Sinauer Publishing.

Isayeva, N. (1993). *Shankara and Indian Philosophy.* Albany, NY: SUNY Press.

Isayeva, N. (1995). *From Early Vedanta to Kashmir Shaivism.* Albany, NY: SUNY Press.

Jagadananda, S. (1989). *Upadesha Sahasri of Sri Shankaracharya.* Mylapore, Madras, India: Sri Ramakrishna Math.

Jedrczak, A. & Clemens, G. (1984). The TM-Siddhi program and filed independence. *Perceptual and Motor Skills, 59,* 999-1000.

Jedrczak, A., Toomey, M., & Clemens, G. (1986). The TM-Siddhi program, age, and brief testing of perceptual-motor speed and nonverbal intelligence. *Journal of Clinical Psychology, 42,* (1), 161-164.

Jezzard, P., Matthews, P.M., & Smith, S.M. (2001). *Functional MRI: An Introduction to Methods.* New York: Oxford University Press.

Josipovic, Z. (1990). *Self-Recognition Psychotherapy.* Unpublished master's thesis, John F. Kennedy University, Orinda, CA.

Josipovic, Z. (1998). *Bliss and Authenticity.* Unpublished manuscript.

Kabat-Zinn, J. (1982). An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation. *General Hospital Psychiatry 4,* 33-47.

Kabat-Zinn, J., Lipworth, L. & Burney, R. (1985). Clinical use of mindfulness meditation for the self-regulation of chronic pain. *Journal of Behavioral Medicine, 8,* (2), 163-190.

Kabat-Zinn, J., Masson, J., & Kristeller, J. (1992). Effectiveness of a meditation based stress reduction program in the treatment of anxiety disorders. *American Journal of Psychiatry, 149,* (7), 936-943.

Kabat-Zinn, J., Wheeler, E., Light, T., Skilling, A., Scharf, M., Cropley, et al. (1998). Influence of mindfulness-based stress reduction intervention on rates of skin clearing in patients with moderate to severe psoriases undergoing phototherapy (UVB) and photo-chemotherapy (PUVA). *Psychosomatic Medicine, 60,* (5), 625-632.

Karnath, H-O. (1999). Spatial orientation and the representation of space with parietal lobe lesions. In N. Burgess, K.Jeffery, & J. O'Keefe (Eds.), *The Hippocampal and Parietal Foundations of Spatial Cognition,* (pp. 51-66). Oxford, UK: Oxford University Press.

Kasamatsu, A. & Hirai, T. (1969). An Electroencephalographic Study of the Zen Meditation (Zazen). *Psychologia. 12,* 205-225. In Shapiro, D. & Walsh, R. (Eds.) *Meditation: Classic and Contemporary Perspectives.* (pp. 480-492). Hawthorne, NY: Aldine Publishing.

Katz, S. (1978). Language, Epistemology and Mysticism. In *Mysticism and*

Philosophical Analysis. Oxford: Oxford University Press.

Kaufman, M. (2005). Meditation gives brain a charge, study finds. *Washington Post.* Monday, January 3, 2005; Page A05

Kjear, T.W., Bertlesen, C., Piccini, P., Brooks, D., Alving, J. & Lou, H.C. (2002). Increased dopamine tone during meditation-induced change of consciousness. *Brain Res. Cogn. Brain Res.* 13, (2), 255-9.

Kjaer, T.W. et al. (2002). Regional Cerebral Blood Flow During Light Sleep—a H2O PET Study. *Journal of Sleep Research. 11,* 201-207.

Klostermaier, K. (1994). *A Survey of Hinduism.* Albany, NY: SUNY Press.

Koch, C. (2004). *The Quest for Consciousness.* Retrieved on February, 12, 2005 from www.sci-con.org

Kochumuttom, T. A. (1999). *A Buddhist Doctrine of Experience: A New Translation and Interpretation of the Works of Vasubhandu the Yogacharin.* Delhi, India: Motilal Banarsidass Publishers.

Kongtrul, J.L.T.(1995). *Myriad Worlds.* Ithaca, NY: Snow Lion.

Kongtrul, J.L.T. (1996) *Creation and Completion.* Boston, MA: Wisdom Publications.

Kosslyn, S.M., Ganis, G. & Thompson, W.L., (2001). Neural Foundations of Imagery. *Nature Reviews Neuroscience. 2,* 635-642.

Kothari, et al. (1973). *Am. Heart J. 86: 282-284.* PubMed

LaBerge, S. (2000). Lucid dreaming: Evidence and methodology. *Behavioral and Brain Sciences 23,* (6), 962-3.

Laufs, H., Krakow, K., Sterzer, P., Beyerle, A., Selek-Haddadi, A. &

Kleinschmidt, A. (2003). Electroencephalographic signatures of attentional and cognitive default modes in spontaneous brain activity fluctuations at rest. *PNAS 100(19)*, 11053-11058.

Lazar, S., Bush, G., Gollub, R.L., Fricchione, G.L., Khalsa, G. & Benson, H. (2000). Functional Brain Mapping of the Relaxation Response and Meditation. *Neuroreport, 11* (7), 1-5.

Lazar, S., Kerr, C.E., Wasserman, R.H., Grey, J.R., Greve, D.N., Treadway, M.T., et al., (2005). Meditation experience is associated with increased cortical thickness. *Neuroreport, 16,* (17), 1893-1897.

LeDoux, J.E. (2000). Emotion Circuits in the Brain. *Annual Review of Neuroscience, 23,*155-184.

LeDoux, J.E. (2006). *Empirical Approaches to Consciousness.* Panel presentation at the Mind and Reality Conference, Columbia University, NY, Feb. 25-26, 2006.

Lehmann, D., Faber, P.L., Acherman, P., Jeanmonod, D., Gianotti, R.R. & Pizzagalli, D. (2001). Brain sources of EEG gamma frequency during volitionally meditation-induced, altered states of consciousness, and experience of the self. *Psychiatry Research: Neuroimaging Section, 108,* 111-121.

Levine, D.N., Warach, J. & Farah, M.J. 1985. Two visual systems in mental imagery. *Neurology, 35,* 1010-1018.

Leynes, et al. (2003). Investigating the Encoding and Retrival of Intentions with Event-Related Potentials. *Consciousness and Cognition. 12,* 1-18.

Linden, W. (1973). The relationship between the practice of meditation by school children and their levels of field dependence-independence, test anxiety, and reading achievement. *Journal of Consulting and Clinical Psychology, 41,*139-143.

Lingpa, D. (1994). *Buddhahood Without Meditation.* Junction City, CA: Padma Publishing.

Lingpa, K.D. (2001). Teachings on Dzogchen Trekcho. Public lecture, Kingston, NY.

Llinas, R., Ribary, U., Contreras, D. and Pedroarena, C. (1998) The neuronal basis for consciousness. *Phil. Trans. R. Soc. Lond. B , 353*, (1377), 1841-1849.

Llinas, R. (2001). *I of the Vortex.* Cambridge, MA: MIT Press.

Loomis, J.M., (1992). Distal Attribution and Presence. *Presence, 1* (1), 113-119.

Lou, H.C., Kjaer, T.W., Friberg, L., Wildschiodtz, G., Holm, S. & Nowak, M. (1999). A O-H2O PET Study of Meditation and the Resting State of Normal Consciousness. *Human Brain Mapping, 7,* 98-105.

Lou, H.C., Luber, B., Crupain, M., Keenan, J.P., Nowak, M., Kjaer, et al. (2004). Parietal cortex and representation of the mental Self. *Proceeds of the National Academy of Sciences of United States of America. 101 (17),* 6827-6832.

Loy, D. (1998). *Nonduality: A Study in Comparative Philosophy.* Amherst, NY: Humanity Books.

Luna, B., Minshew, N.J., Garver, K.E., Lazar, N.A., Thulborn, K.R., Eddy et al.

(2002). Neocortical system abnormalities in autism: an fMRI study of spatial working memory. *Neurology, 59,* (6), 834-840.

Lutz, A., Greischar, L.L., Rawlings, N.B., Ricard, M. & Davidson, R.J. (2004). Long-term meditators self-induce high-amplitude gamma synchrony during mental practice. *Proceeds of the National Academy of Sciences of the United States of America, 101 (46),* 16369-16373.

Lutz, A., Brefczynski-Lewis, J.A. & Davidson, R.J. (2004). *Loving-kindness and compassion meditation results in unique patterns of fMRI activation and enhances the reactivity of the insula/cingulate circuitry to negative stimuli in meditators.* Madison, WI: Keck Laboratory, University of Wisconsin-Madison.

Maharshi, R. (2000). *Talks with Ramana Maharshi.* Rochester, VT: Inner Directions.

Mason, L.I., Alexander, C.N., Travis, F., Marsh, G., Orme-Johnson, D., Gackenbach et al. (1997). Electrophysiological correlates of higher states of consciousness during sleep in long term practitioners of the transcendental meditation program. *Sleep, 20,* 102-110.

Mellet, et al. (1998). Reopening the Mental Imagery Debate: Lessons from Functional Anatomy. *Neuroimage, 8,* 129-139.

Metzinger, T. (Ed. (2002). *Neural Correlates of Consciousness.* Cambridge, MA: MIT Press.

Miller, E.K. (2000). The Prefrontal Cortex and Cognitive Control. *Nature reviews Neuroscience, 1,* 59-65.

Miller, E.K. & Cohen, J.D. (2001). An Integrative Theory of Prefrontal Cortex Function. *Annual Review of Neuroscienc., 24,* 167-202.

Milner, A.D. & Goodale, M.A. (1995). *The Visual Brain in Action.* Oxford: Oxford University Press.

Mingyur, R. (2003). Lectures on Mahamudra. KTD, Woodstock, NY.

Muller-Ortega, P.E. (1989) *Triadic Heart of Shiva.* Albany, NY: SUNY Press.

Murphy & Donovan, (1999) *The Physical and Psychological effects of Meditation.* Novato, CA: Institute of Noetic Sciences.

Namgyal, D. T. (2001). *Clarifying the Natural State.* Kathmandu, Nepal: Ranjung Yeshe Publications.

Newberg, A. (2000) The Neurophychology of Religious and Spiritual Experience. *Journal of Consciousness Studies,* 7, (11-12), 251-266.

Newberg, A. (2005). *Field Analysis of the Neuroscientific Study of Religious and Spiritual Phenomena.* Downloaded on July 20, 2005 from www.metanexus.org/tarp.

Newberg A, Alavi A, Baime M, Pourdehnad M, Santanna J, d'Aquili E. (2001). The measurement of regional cerebral blood flow during the complex cognitive task of meditation: a preliminary SPECT study. *Psychiatry Res. 106,* (2), 113-122.

Newberg, A. & D'Aquilli, E. (2002). *Why God Won't Go Away.* New York: Ballantine Books.

Newberg, A. & Iversen, J. (2003). The neural basis of the complex mental task of meditation: neurotransmitter and neurochemical considerations. *Medical*

Hypotheses, 61, (2), 282-291.

Nidich, S.I., Seeman, W., & Seilbert, M. (1973). Influence of TM on state anxiety. In Orme-Johnson, D.W. & Farrow, J.T. (Eds.) (1977), *Scientific Research on the Transcendental Meditation Program: Collected Papers, Vol. I,* (pp. 434-438), New York: M.E.R.U. Press.

Nikhilananda, S. (1949). *Vedantasara of Sadhanananda Yogindra.* Mayavati Almora, Himalayas, India: Advaita Ashrama.

Nityaswarupananda, S. (1981). *Astavakra Samhita.* Calcutta, India: Advaita Ashrama.

Norbu, N. (1987). *The Cycle of Day and Night.* Barrytown, NY: Station Hill Press.

Norbu, N. & Lipman, K. (1987). *Primordial Experience.* Boston, MA: Shambala.

Northoff. G. (2003). Qualia and ventral prefrontal cortical function. *Journal of Consciousness Studies, 10,* (8), 14-48.

Northoff, G., Heinzel, A., de Greck, M., Berpohl, F., Dobrowolny H. & Panksepp, J. (2006). Self-referential processing in our brain-A meta-analysis of imaging studies on the self. *NeuroImage, in press.*

Orme-Johnson, D. & So, K. (2001). Three randomized experiments on the influence of transcendental meditation technique on cognition. *Intelligence, 29,* (5), 419-440.

Pan, W., Zhang, L. & Xia, Y. (1994).

Pelletier, K. (1974). Influence of Transcendental Meditation upon autokinetic perception. *Perceptual and Motor Skills, 39,* 1031-1034.

Peng, C.K., Mietus, J.E., Liu, Y., Khalsa, G., Douglas, P.S., Benson et al. (1999). Exaggerated heart rate oscillations during two meditation techniques. *International Journal of Cardiology, 70,* 101-107.

Peninston, E. & Kulkovsky, P. (1990). Alcoholic Personality and Alpha-Theta Training. *Medical Psychotherapy, 3,* 37-55.

Phylyshyn, Z. (2002). *Return of Mental Image.* New Brunswick, NJ: Rutgers Center for Cognitive Science.

Pizzagali, et al. (2001). Anterior Cingulate Activity as a Predicator of Degree of Treatment Response in Major Depression. *American Journal of Psychiatry, 158,* 405-415.

Potter, K.H. (2002). *Presuppositions of India's Philosophies.* Delhi, India: Motilal Banarsidass.

Rabjam, L. (1998). *The Precious Treasury of the Way of Abiding.* Junction City, CA: Padma Publishing.

Rabjam, L. (2001a). *The Precious Treasury of the Basic Space of Phenomena.* Junction City, CA: Padma Publishing.

Rabjam, L. (2001b). *A Treasure Trove of Scriptural Transmission: A Commentary on the Precious Treasury of the Basic Space of Phenomena.* Junction City, CA: Padma Publishing.

Rabjam, L. (2002). *The Practice of Dzogchen.* Ithaca, NY: Snow Lion.

Radhakrishnan, S. (1995). *The Principal Upanishads.* New Delhi, India:HarperCollins.

Rahula, W. (1974). *What the Buddha Taught.* New York, NY: Grove Press.

Raichle, M.E. & Gusnard, D.A. (2005). Intrinsic brain activity sets the stage for expression of motivated behavior. *J. of Comp. Neurology, 493,* 167-176.

Raichle, M.E., MacLeod, A.M., Snyder, A.Z., Powers, W.J., Gusnard, D.A. & Shulman, G.L. (2001). A default Mode of Brain Functioning. *PNAS, 98,* (2), 676-682.

Ramachandran, V.S. (1998). *Phantoms in the Brain.* New York, NY: William Morrow.

Rana, S. (2001). *Madhyamaka Buddhism vis-à-vis Hindu Vedanta.* Retrieved on May 18, 2004, from www.orientalia.org/articles/Madhyamaka

Rani, N.J. & Rao, P.V.K. (2001). Effects of meditation on attention processes. *Journal of Indian Psychology, 18,* (1-2), 56-60.

Rangdrol, T.N. (1989). *Lamp of Mahamudra.* Hong Kong: Rangjung Yeshe.

Rangdrol, T.N. (1990). *The Circle of the Sun.* Hong Kong: Rangjung Yeshe.

Revonsuo, A. (2001). Can functional brain imaging discover consciousness in the brain? *Journal of Consciousness Studies, 8,* (3)

Reynolds, J.M. (1989). *Self-liberation through seeing with naked awareness.* Barrytown, NY: Station Hill Press.

Rinbochay, L. (1997) *Meditative States in Tibetan Buddhism.* Boston, MA: Wisdom Publications.

Rose, S. (2005). *The Future of the Brain.* New York: Oxford University Press.

Roth, G. (2002). *The evolution and ontogeny of consciousness.* In Metzinger, T. (Ed.) *Neural Correlates of Consciousness.* (pp. 77-97), Cambridge, MA: The MIT Press

Rothenberg A. & Muller, R. (1999). *Variable place-cell coupling to continuously viewed stimulus: evidence that the hippocampus act as a perceptual system.* In N. Burgess, K.Jeffery, & J. O'Keefe (Eds.), *The Hippocampal and Parietal Foundations of Spatial Cognition*, (pp. 186-202). Oxford, UK: Oxford University Press.

Rowan, A.J. & Tolunsky, E. (2003) *Primer of EEG.* Philadelphia, PA: Elsevier Science.

Saraswathi, S.R. (1989). *Tripura Rahasya.* Tiruvanamalai, India: Sri Ramanashram.

Saraswathi, S.R. (2003). *Lamp of Non-Dual Knowledge.* Bloomington, IN: World Wisdom.

Sayadaw, M. (1978) *The Progress of Insight.* Kandy, Sri Lanka: Buddhist Publication Society.

Searle, J.R. (2002). Why I am not a property dualist. *Journal of Consciousness Studies, 9,* (12), 57-64.

Searle, J.R. (2005). Consciousness: What We Still Don't Know. *The New York Review of Books, 52,* (1).

Shapiro, D.H. (1980). *Meditation: Self Regulation Strategy and Altered State of Consciousness.* Hawthorne, NY: Aldine Publishing.

Shapiro, D.H. & Walsh, R.N. (Eds.) (1984). *Meditation: Classic and Contemoprary Perspectives.* Hawthorne, NY: Aldine Publishing.

Shapiro, S.L. & Walsh, R.N. (2003). An analysis of recent meditation research

and suggestions for future directions. *The Humanistic Psychologist, 31,* 86-114.

Sharma, C. (1987). *Critical Survey of Indian Philosophy.* Delhi, India: Motilal Banarsidas.

Shear, J. & Jevning, R. (1999). Pure Consciousness: Scientific Exploration of Meditation Techniques. *Journal of Consciousness Studies, (6) No.2-3,* 189-209.

Shepetin, I. (2004). Private Talks on Advaita Vedanta. Woodstock, NY

Sherab, P. & Dongyal, T. (1998). *Lion's Gaze.* Boca Raton, FL: Sky Dancer Press

Sim, M.K. & Tsoi, W.F. (1992). The effects of centrally acting drugs on the EEG correlates of meditation. *Biofeedback Self Regul. 17,* (3), 215-220.

Singh, J. (1998). *Vijnanabhairava.* New Delhi, India: Motilal Banarsidass.

Situ, T. (2000). Public talk on Mahamudra given at KTD, Woodstock, NY, February 12, 2000.

Smith, H. (2000). *Cleansing the Doors of Perception.* New York, NY: Tartcher/Putnam.

Smith, J.C. (1975). Psychotherapeutic effects of Transcendental Meditation with controls for expectation of relief and daily sitting. *Journal of Consulting and Clinical Psychology, 44,* (4), 630-637.

Snow, P.J. (2003). Charting the Domains of Human Thought. *Journal of Consciousness Studies, 10,* (11), 3-17.

Sridevi, K. & Rao, P.V.K. (2003). Temporal effects of meditation on cognitive style. *Journal of Indian Psychology, 21,* (1), 38-51.

Stutchburry, E. (1998). *Tibetan Meditation, Yoga and Healing Practices: Mind Body Interconnections.* In: The Embodiment of Mind: Eastern and Western Perspectives. DelMonte, M. & Haruki, Y. (Eds.) (pp.131-143), Netherlands: Eburon Publishers.

Suzuki, D.T. (1932). *Lankavatara Sutra.* London, UK: Routlege Kegan Paul.

Talairach, J. & Tournoux, P. (1988). *Co-Planar Stereotaxic Atlas of the Human Brain.* New York: Thieme Medical Publishing.

Tart, C.T. (Ed.), (1972). *Altered States of Consciousness.* Garden City, NY: Doubleday Anchor.

Taylor, J.G. (2002). Paying attention to consciousness. *Trends in Cognitive Science* (6), 206-210.

Taylor, J.G. (2003). Pure Consciousness in Meditation and the Self. Retireved on April 20, 2004, form www.sci-con.org

Thier, P. & Karnath, H.O. (1997). *Parietal Lobe Contributions to Orientation in 3-D Space.* Berlin, Germany: Springer-Verlag.

Traleg, K.R. (1993). *The Influence of Yogachara on Tantra.* Victoria, Australia: Kagyu E-Vam Buddhist Institute.

Trangu, K. (2001). *Five Buddha Families and Eight Consciousnesses.* Auckland, New Zealand: Zhyisil Chkyi Ghatsal Publications.

Trangu, K. (2002). *Everyday Consciousness and Buddha-Awakening.* Ithaca, New York: Snow Lion.

Trangu, K. (2005). King's doha of Saraha. *Densal, 17,* (1), 6-10.

Travis, F. (1994) The Junction Point Model. *Dreaming, 4*, (2), 91-105.

of the effects of concentrative and mindfulness meditation on sustained attention. *Mental Health, Religion & Culture, 2,* (1), 59-70.

Varela, F., Lachaux, J.P., Rodriguez, E., and Martinerie, J. (2001). The brainweb: phase synchronization and large-scale integration. *Nat Rev Neurosci, 2,* 229-39

Varela, F. & Shear, J. (2002). *View from Within.* Thorverton, UK: Imprint Academic. (Original work published 1999).

Venkatesananda, S. (1984). *The Concise Yoga Vasishtha.* Albany, NY: SUNY Press

Vireshwarananda, S. (1993). *Brahma Sutras with commentary of Sri Shankara.* Calcutta, India: Advaita Ashrama.

Virupakshananda, S. (1995). *Samkhya Karika of Ishvara Krishna.* Mylapore, Madras: Sri Ramakrishna Math.

Vogeley, K., Kawasaki, Y., Jung, V., Zilles, K., Bogerts, B. & Falkai, P. (1996). Developmental disturbances in the prefrontal neuronal network and its relevance to schizophrenia. Retrieved June 12, 2004 from http://www.zynet.co.uk/imprint/Tucson/2.htm

Wallace, B.A. (2003). *Buddhism and Science: Braking Down the Barriers.* New York, NY: Columbia University Press.

Wallace, B.A. (2004). Lectures on Yogachara philosophy. Mind Life Institute Summer Research Conference. Garrison, NY: Mind Life Institute & Garrison Institute. (June 18-25, 2004).

Wallace, R.K., Benson, H., Wilson, A.F. (1971). A wakeful hypometabolic

Society. 15, (6).

Valentine, E.R. & Sweet, P.L.G. (1999). Meditation and attention: a comparison of the effects of concentrative and mindfulness meditation on sustained attention. *Mental Health, Religion & Culture, 2,* (1), 59-70.

Varela, F., Lachaux, J.P., Rodriguez, E., and Martinerie, J. (2001). The brainweb: phase synchronization and large-scale integration. *Nat Rev Neurosci, 2,* 229-39

Varela, F. & Shear, J. (2002). *View from Within.* Thorverton, UK: Imprint Academic. (Original work published 1999).

Venkatesananda, S. (1984). *The Concise Yoga Vasishtha.* Albany, NY: SUNY Press

Vireshwarananda, S. (1993). *Brahma Sutras with commentary of Sri Shankara.* Calcutta, India: Advaita Ashrama.

Virupakshananda, S. (1995). *Samkhya Karika of Ishvara Krishna.* Mylapore, Madras: Sri Ramakrishna Math.

Vogeley, K., Kawasaki, Y., Jung, V., Zilles, K., Bogerts, B. & Falkai, P. (1996). Developmental disturbances in the prefrontal neuronal network and its relevance to schizophrenia. Retrieved June 12, 2004 from http://www.zynet.co.uk/imprint/Tucson/2.htm

Wallace, B.A. (2003). *Buddhism and Science: Braking Down the Barriers.* New York, NY: Columbia University Press.

Wallace, B.A. (2004). Lectures on Yogachara philosophy. Mind Life Institute Summer Research Conference. Garrison, NY: Mind Life Institute &

Garrison Institute. (June 18-25, 2004).

Wallace, R.K., Benson, H., Wilson, A.F. (1971). A wakeful hypometabolic physiologic state. *American Journal of Physiology, 221,* (3), 795-799. In Shapiro, D. H. & Walsh, R.N. (Eds.) (1984). *Meditation: Classic and Contemoprary Perspectives.* Hawthorne, NY: Aldine Publishing.

Walsh, R. (1996). Meditation research: the state of the art. In: Scotton, B.W., Chinen, A.B., Battista, J.R . (Eds.) *Textbook of Transpersonal Psychiatry and Psychology.* (pp. 167-175). New York: Basic Books.

Wayman, A. (1999). *Yoga of the Guyasamajatantra.* New Delhi, India: Motilal Banarsidass.

Wenk-Somraz, H. (2005). Meditation can reduce habitual responding. *Alternative Therapies in Health and Medicine, 1,* (2), 42-58.

Wilber, K. (1997). *Eye of the Spirit.* Boston, MA: Shambala.

Wilber, K. (2000 a). *Integral Psychology.* Boston, MA: Shambala.

Wilber, K. (2000 b). *One Taste.* Boston, MA: Shambala.

Wise, A. (2002). *Awakening the Mind.* New York, NY: Tarcher/Putnam.

Wood, J.N. & Grafman, J. (2003). Human Prefronal Cortex: Processing and Representational Perspectives. *Nature Neuroscience Reviews. 4,* 139-147.

Woodroffe, S.J. (1918). *Shakti and Shakta.* Retrieved on March 1, 2005, from http://www.sacred-texts.com/tantra/sas/sas18.htm

Woolfolk et al. (1982). Effects of progressive relaxation and meditation on cognitive and somatic manifestations of daily stress. *Behavioral Research*

Therapy, 20, 461-467.

Young, J.D. & Taylor, E. (1998). Meditation as a Voluntary Hypometabolic State of Biological Estivation. *News in Physiological Sciences, 13,* (3), 149-153.

Yu, L.K. (1971). *Practical Buddhism.* London UK: Rider and Company.

Zacks, J. Rypma, B., Gabrielli, J.D., Tversky, B. & Glover, G.H. (1999). Imagined transformations of bodies: and fMRI investigation. *Neuropsychologia, 37,* 1029-1040.

Zajonc, A. (Ed.) (2004). *The New Physics and Cosmology.* New York, NY: Oxford University Press.

Zarahn, E., Aguire, K. & D'Esposito, M. (1997). Empirical Analysis of BOLD fMRI Statistics. *Neuroimage, 0,* 1-19.

Zohar, D. & Marshal, I. (2000) *SQ—Spiritual Intelligence.* New York, NY: Bloomsburry Publishing.